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ABSTRACT

This document contains materials developed by a project to provide a competency-based curriculum guide for laser technology at the community college level. An abstract of the final report is included. Next, the 17 job competencies determined as necessary to meet the job description of laser technician are listed. A career ladder and qualifications for each career are also provided. The three-part curriculum guide is divided into 16 units: Mathematics--2 units (Algebra, Trigonometry); Electronics--6 units (Basic Electricity I-III, Basic Electronics I-II, Electronic Communication); and Laser--8 units (Laser Safety, Introduction to Lasers, General Optics I-II, Laser Optics, Laser Operation, Laser Measurements, Laser Applications). Each unit is divided into objectives, for each of which this information is provided: specifics (topics or concepts), proficiencies/specific objectives, evaluation, and references. A brief summary of teaching and evaluation strategies follows. The final section of the document contains instructional resources, including a list of lab equipment (item, manufacturer, model); bibliographic listings for laser and optics, electronics, physics, and mathematics (publishers addresses are provided); list of journals that have published laser-related articles; and a list of audiovisual resources. (YLB)

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Competency-Based Curriculum Guide for Laser Technology

John J. Fioroni
College of DuPage
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Final Report Abstract Format

Title of Project:

Laser Technology Curriculum Guide

Funding Agreement Number:

R-33-11-D-0542-304

Principal Investigators:

John J. Fioroni

Institution:

College of DuPage

Location:

Glen Ellyn, IL

Time Period Covered:

September 1980 through June 1981

Objectives of the Project:

1. Determine job competencies
2. Determine career ladder
3. Formulate measureable course objectives
4. Determine teaching and evaluation strategies
5. Identify instructional resources
6. Arrange for field testing

Procedures:

1. Meet with advisory committee
2. Research industry
3. Develop measurable objectives
4. Develop evaluation strategies
5. Literature search
6. Contact ISBE/DAVTE and community colleges for field testing

Expected Contribution or Potential Impact on Vocational Education:

This program will provide needed personnel to meet the manpower needs of the Laser Technology industry in our state.

Products Delivered: (Indicate titles, types, quantity, recipients and date of delivery)

Twelve copies to DAVTE

Expenditure of Funds: all funds used

Paid participants: (resumes enclosed)

Conference/Workshop summary: none held

Resource listing: none purchased

Accomplishments:

Objective 1, Determine job competencies for Laser Technology.
Objective 2, Determine career ladder and criteria for promotion.
Objective 3, Formulate measurable course objectives.
Objective 4, Determine teaching and evaluation strategies for each objective.
Objective 5, Identify instructional resources.
Objectibe 6, Arrange for field testing.

Major Activities:

(a) monthly meetings were held with the advisory council,

(b) project director went to North Central Technical Institute, Wausau, WI to observe the Laser Technology program at that institute,

(c) project director went to DAVTE, Springfield, IL to discuss project with DAVTE staff.

Problems:

Project deadline was not met due to project director not beginning work until late October. Major problem with instructional resources is finding textbooks written for the non-engineer, non-advanced mathematics student.

Other problems were "in house" but they did not delay the delivery of the final product.

Publicity: none

Resource Persons:

Mr. Richard Cunningham
Kiver Publications
222 W. Adams St.
Chicago, IL 60606

Mr. Walter Bronian
Intra-Action Corp.
3716 Warren Ave.
Bellwood, IL 60104

Mr. Ed Wood
FJW Industries
215 Prospect Ave.
Mt. Prospect, IL 60056

Mr. Ron Ohlhaber
Belden Corp.
2000 S. Batavia Rd.
Geneva, IL 60134

Summations of Evaluation Data Collected: to be field tested

Statement of Impact:

This program will provide the necessary manpower needs for technicians in Laser-related industries within the state of Illinois.

Conclusions and Recommendations:

This program will not have applicability outside of the Chicago area. Future programs should be developed to meet the needs for the area that has the greatest need thereby maximizing the return for tax dollar spent of program implementation.

Staff Development: none

Other Activities:

I made a trip to North Central Technical Institute, Wausau, WI, without renumeration, in order to observe the Laser Program at that institution. This meeting provided invaluable information on laboratory supplies, lab space, organization of labs, safety features, and course materials.

Materials Developed: included

RESUME

John J. Fioroni
517 Colford
West Chicago, IL 60185
(312) 231-9521

Born: January 8, 1949
Height: 5'9"
Weight: 175 lbs.
Marital Status: Married
Children: 1

Education:

Glenbard East High School, Lombard, Illinois	1966-1967
College of DuPage, Glen Ellyn, Illinois	1971-1973
University of Illinois, Chicago Circle, Chicago, Illinois	1974-1976
Received Associate of Arts degree from College of DuPage	June, 1973
Received Bachelor of Arts degree from University of Illinois, Chicago Circle	June, 1976

Graduate:

University of South Florida, Tampa, Florida	1976-1977
Loyola University of Chicago, Chicago, Illinois	1980-Present

Work Experience:

1978-Present	Instructor, Basic Electronics, CETA Program College of DuPage
1977-1978	Electrician, Delta Electric, Tampa, Florida
1976-1977	Research Assistant, University of South Florida, Tampa, Florida
1974-1976	Lab Aide, University of Illinois, Chicago Circle, Chicago, Illinois
1971-1973	Full-time student, worked part-time on odd jobs
1967-1971	Military Service, USAF

RESUME

James Boyd
7N641 Route 59
Bartlett, IL 60103
(312) 837-8778

Born: 2/25/28
Marital Status: Married

Education:

Doctorate (in progress) - Northern Illinois University
All work completed for Ed.D in Instructional Technology except dissertation.
Post M.A. - Illinois Institute of Technology - 1965-67
Twenty-seven semester credits in graduate mathematics.
Masters Degree - University of Minnesota - 1965
Degree in Curriculum and Instruction with minor in Mathematics and twenty-one quarter credits beyond Masters Degree.
Bachelors Degree - David Lipscomb College, Nashville, Tennessee
Graduated in 1952 with major in Speech and minors in Mathematics and Education.
High School - Franklin High School, Franklin, Tennessee
Graduated in 1946.
Other - I have also attended numerous seminars on computers, computer-assisted instruction, instructional design, and management.

Work Experience:

1968 - Present	College of DuPage Present - Director of Instructional Design Director of Computer Center Associate Director of Computer Center Director of Technical Development
1966 - 1968	Chairman of Mathematics Department Community High School District #88 Villa Park, Illinois
1963 - 1966	Mathematics Teacher - Central High School, St. Paul, Minnesota
1952 - 1963	Minister in the Church of Christ

Miscellaneous:

1975 - 1976	Executive Director of Association of Community Colleges for Excellence in Systems and Service (ACCESS).
1974 - Present	Director for Project Discover. Have participated in numerous professional conferences at the national level.

Publications:

CVIS User's Manual
DISCOVER - Technical User's Manual
DISCOVER - Installation Guide

OBJECTIVE I

JOB COMPETENCIES

Interviews with advisory council has generated the following job description:

> Laser technician, any person who has the mathematical and technical knowledge to safely operate, calibrate, maintain, and repair any system employing lasers and electro-optical devises.

In order to satisfy this job description the participant must be proficient in each of the following competencies:

1. The participant will be proficient in algebra and trigonometry.
2. The participant will be able to perform ray tracing through an optical system.
3. The participant will be proficient in the assembly and disassembly of an optical system.
4. The participant will possess a broad based knowledge of electronics.
5. The participant will possess a broad based knowledge of optics.
6. The participant will have the knowledge and skill to align lasers, optical systems, and associated electronic devices.
7. The participant will possess the skill to hold these alignments to exacting tolerances.
8. The participant will possess the knowledge to turn on and turn off a high power laser.
9. The participant will possess the necessary knowledge and skill to make repairs on a laser.
10. The participant will possess the necessary knowledge and skill to make repairs on an optical system.
11. The participant will possess the necessary knowledge and skill to make repairs on associated electronic devices.
12. The participant will be able to clean optical devices with out degrading surface quality.
13. The participant will be skilled in the operation at optical test equipment.
14. The participant will be skilled in the operation of electronic test equipment.
15. The participant will be able to analyze diagnostic test data so as to make repairs or adjustments on a system to bring it into specifications.

16. The participant will possess a broad based knowledge of electronics and optics as they relate to laser/electro-optical systems and their applications.

17. The participant will follow all safety procedures.

The advisory council was quite strong on two points. First they will not hire anyone as a laser technician if the person does not possess each of three competencies.

Second, any person hired as a laser technician who does not follow safety procedures will be promptly terminated.

The following units should be taught for each objective:

#1: Units A1 and A2

#2: Units C3, C4, and C5

#3: Units C3, C4, C5, and C8

#4: Units B1, B2, B3, B4, B5, and B6

#5: Units C3, C4, and C5

#6: Units C5, C7, and C8

#7: Units C5, C7, and C8

#8: Unit C6

#9: Units C2, C6 and C8

#10: Units C3, C4, C5 and C7

#11: Units B4, B5, and B6

#12: Units C3, C4, and C5

#13: Units C7

#14: Units B4, B5, and B6

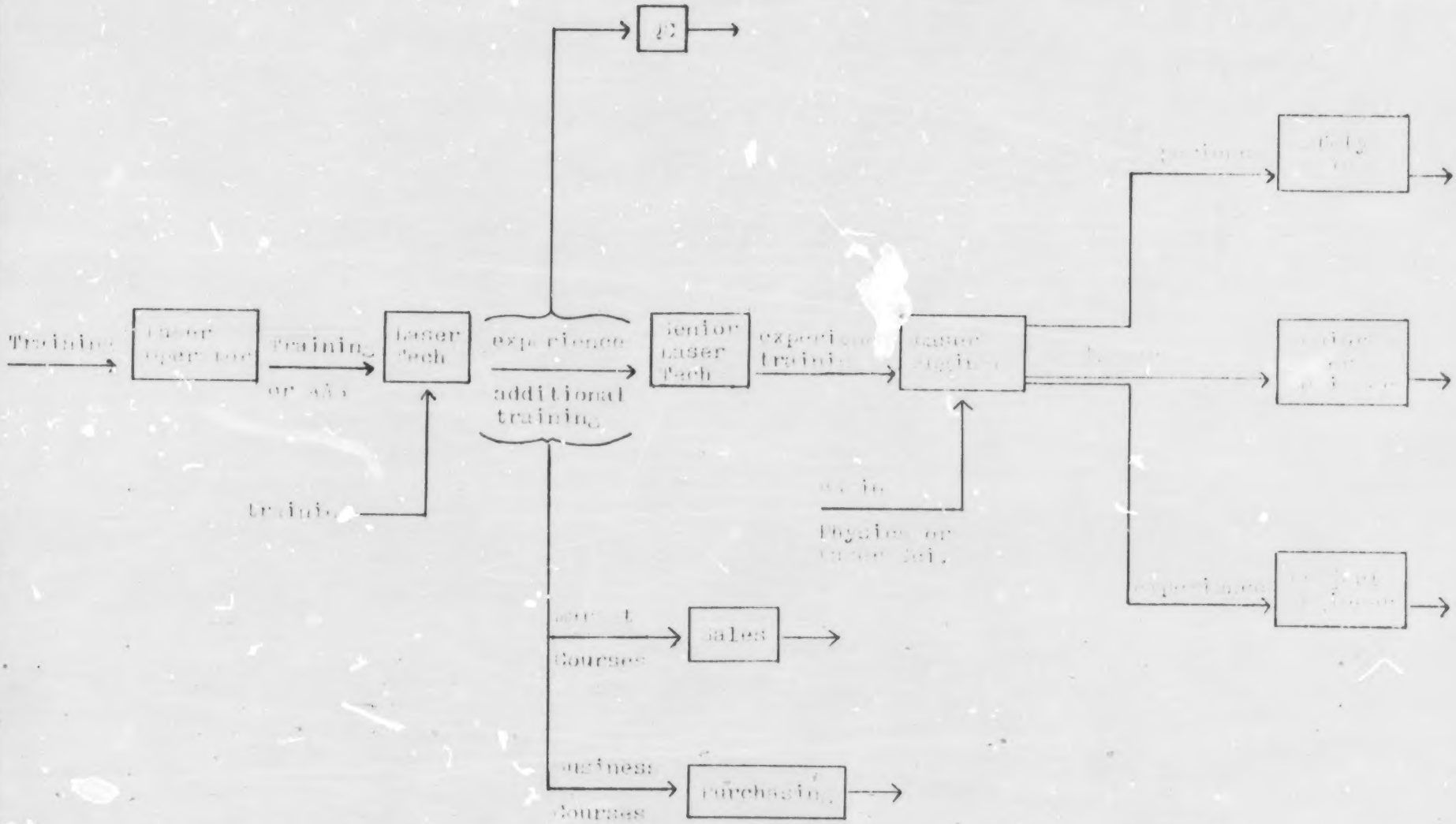
#15: Units C7 and C8

#16: Units C7 and C8

#17: Unit C1

Objective 2

Career Ladder


Trainin
Laser
Tech
experience
additional
trainin
Junior
Laser
Tech
sales
Courses
Purchasin

CAREER

Laser Operator	Completion of courses: Safety Basic Lasers Optics I & II Laser Optics
Laser Technician	Completion of entire program
Senior Laser Tech	3-5 years experience & additional course work at Baccalariete level in Physics, Lasers, or Engineering (if course work appropriate)
Laser Engineer	5-8 years experience & additional course work at Baccalariete level in Physics, Lasers, or engineering or BS degree in Physics or Lasers, perhaps Engineering if course work appropriate.
Senior Laser Engineer	5 years experience, some graduate work in physics
Sales	Experience with types of systems manufactured, Marketing courses helpful.
Purchasing	Experience with types of systems manufactured, Business courses helpful.

Objective 3

Curriculum Guide

Outline of Units

A. Mathematics

1. Algebra
2. Trigonometry

B. Electronics

1. Basic Electricity I
2. Basic Electricity II
3. Basic Electronics III
4. Basic Electronics I
5. Basic Electronics II
6. Electronic Communication

C. Laser

1. Laser Safety
2. Introduction to Lasers
3. General Optics I
4. General Optics II
5. Laser Optics
6. Laser Operation
7. Laser Measurements
8. Laser Applications

Unit: Algebra (A1)

Objective 1: Properties of Real Numbers

This objective will introduce the student to the basic principles involved when working with real numbers.

Specifics:

(1) sets and symbolism
(2) properties of real numbers
(3) basic arithmetic operations with real numbers
(4) order of operation

Proficiencies:

Upon completion of this objective the student will be able to:

(a) identify a set of real numbers,
(b) determine what numbers are included within a union or inter section, of sets of real numbers,
(c) add, subtract, multiply and divide real numbers,
(d) identify the order of operation in problems that contain more than one arithmetic operation,
(e) solve problems using sets of real numbers, and
(f) solve problems having more than one arithmetic operation.

Evaluation:

(a) lecture notes
(b) lecture exams

Reference:

Wooton and Drooyan, Intermediate Algebra

Unit: Algebra (A1)

Objective 2: Polynomials

This objective will introudce the student to the operation of polynomial equations.

Specifics:

(1) basic operations
(2) factoring

Proficiencies:

Upon completion of this objective the student will be able to:

(a) add polynomials,
(b) subtract polynomials,
(c) multiply polynomials,
(d) divide polynomials, and
(e) preform factoral function on polynomials.

Evaluation:

(a) lecture notes
(b) lecture exams
(c) other methods

Reference:

Wooton and Drooyan, Intermediate Algebra

Unit: Algebra (A1)

Objective 3: Fractions

In this objective the student will learn the basic procedures used when working with fractions.

Specifices:

(1) basic operations
(2) reducing to lowest terms
(3) complex fractions

Proficiencies:

Upon completion of this objective the student will be able to:

(a) add fractions,
(b) subtract fractions,
(c) multiply fractions,
(d) divide fractions,
(e) add fractions with different denominators,
(f) subtract fractions with different denominators,
(g) multiply fractions with different denominators,
(h) divide fractions with different denominators,
(i) preform all necessary steps to reduce fractions to their lowest term,
(j) add complex fractions,
(k) subtract complex fractions,
(l) multiply complex fractions, and
(m) divide complex fractions.

Evaluations:

(a) lecture notes
(b) lecture exams
(c) other methods

Reference:

Wooton and Drooyan, Intermediate Algebra

Unit: Algebra (A1)

Objective 4: Exponents, Roots, and Radicals

In this objective the student will learn the use of exponents, roots, and radicals in mathematical equations.

Specifics:

(1) exponents
(2) roots
(3) radicals
(4) integral exponents
(5) rational exponents
(6) products and quotients of expressions containing radical exponents or radicals
(7) changing forms of radicals

Proficiencies:

Upon completion of this objective the student will be able to:

(a) identify an exponent,
(b) describe the operation of an exponent,
(c) identify roots,
(d) describe the operation of a root,
(e) identify a radical,
(f) describe the operation of a radical,
(g) describe integral exponents,
(h) describe rational exponents,
(i) solve problems involving exponents, roots, and radicals, and
(j) change forms of radicals.

Evaluation:

(a) lecture notes
(b) lecture exams
(c) other methods

Reference:

Wooton and Drooyan, Intermediate Algebra

Unit: Algebra (A1)

Objective 5: First-degree Equations

In this objective the student will learn to solve first-degree equations and inequalities involving one variable.

Specifics:

(1) identification
(2) variable isolation
(3) solution set
(4) inequalities

Proficiencies:

Upon completion of this objective the student will be able to:

(a) define a first-degree equations,
(b) solve first-degree equations,
(c) verify that an equation is an identity,
(d) verify that an equation is not an identity,
(e) solve first-degree inequalities, and
(f) graph solution sets for inequalities.

Evaluation:

(a) lecture notes
(b) lecture exams
(c) other methods

Reference:

Wooton and Drooyan, Intermediate Algebra

Unit: Algebra (A1)

Objective 5: Second-dgree Equations

In this objective the student will learn to solve second-dgree equations with one variable.

Specifics:

(1) factoring
(2) completing the square
(3) quadradic formula
(4) inequalities

Proficiencies:

Upon completion of this objective the student will be able to:

(a) identify second-degree equations,
(b) solve second-degree equations by factoring,
(c) solve second-degree equations by completing the square,
(d) solve second-degree equations by use of the quadratic formula,
(e) solve second-degree inequalities, and
(f) graph second-degree inequalities.

Evaluation:

(a) lecture notes
(b) lecture exams
(c) other methods

References:

Wooton and Drooyan, Intermediate Algebra

Unit: Algebra (A1)

Objective 7: Graphs

In this objective the student will learn the functions and graphs of linear equations.

Specifices:

(1) graphs of linear equations
(2) distance and slope formulas
(3) forms of linear equations
(4) graphs of first-degree relationships
(5) second-degree functional graphs

Proficiencies:

Upon completion of this objective the student will be able to:

(a) graph ordered pairs,
(b) define relations,
(c) define function,
(d) determine distance between two points on a graph,
(e) determine the slope of a graph,
(f) graph a standard-form linear equation,
(g) graph a point-slope form linear equation,
(h) graph a slope-intercept form linear equation,
(i) graph sets of equations and inequalities, and
(j) identify the graphs of second-degree equations and inequalities.

Evaluation:

(a) lecture notes
(b) lecture exams
(c) other methods

Reference:

Wooton and Drooyan, Intermediate Algebra

Unit: Algebra (A1)

Objective 8: Systems

In this objective the student will learn systems of equations with two and three variables.

Specifics:

(1) two variables
(2) three variables
(3) solution by simultaneous equations
(4) determinants--two variables
(5) determinants--three variables
(6) solution by substitution--second-degree

Proficiencies:

Upon completion of this objective the student will be able to:

(a) graph systems of equations,
(b) use simultaneous equations to solve systems of equations with two variables,
(c) use simultaneous equations to solve systems of equations with three variables,
(d) define determinants,
(e) use determinants to solve systems of equations with two variables,
(f) use determinants to solve systems of equations with three variables, and
(g) solve second-degree systems of equations by the substitution method.

Evaluation:

(a) lecture notes
(b) lecture exams
(c) other methods

Reference:

Wooton and Drooyan, Intermediate Algebra

Unit: Algebra (A1)

Objective 9: Logarithms

In this objective the student will learn logarithmic and exponential functions.

Specifics:

(1) definition and properties
(2) Base 10
(3) computations
(4) graphs

Proficiencies:

Upon completion of this objective the student will be able to:

(a) define a logarithmic functions,
(b) define an exponential function,
(c) state the three laws of logarithms,
(d) mathematically prove the three laws of logarithms,
(e) define base 10 logarithms,
(f) use a table of logarithms to find a log value for any number,
(g) solve sets of equations involving logs,
(h) use linear interpolation to find nonstandard log values,
(i) change the base of a logarithm, and
(j) graph exponential and logarithmic functions.

Evaluation:

(a) lecture notes
(b) lecture exams
(c) other methods

Reference:

Wooton and Drooyan, Intermediate Algebra

Unit: Trigonometry (A2)

Objective 1: Trigonometric Functions

In this objective the student will learn basic trigonometric functions.

Specific:

(1) Rectangular coordinate system
(2) Trigonometric angles
(3) Definitions of trignometric functions
(4) The unit circle

Proficiencies:

Upon completion of this objective the student will be able to:

(a) define the rectangular coordinate system,
(b) identify quadrants,
(c) locate any point on a graph by rectangular coordinates,
(d) define a trig angle,
(e) define the standard position of an angle,
(f) define the following functions, sin, cos, tan, cot, sec, csc,
(g) solve for each trig function, and
(h) define the unit circle.

Evaluation:

(a) lecture notes
(b) lecture exams
(c) other methods

Reference:

Heineman,
Plane Trigonometry with Tables

Unit: Trigonometry (A2)

Objective 2: Acute angle functions

In this objective the student will learn the trigonometric functions of acute angles.

Specifics:

(1) Trig functions of an acute angle
(2) Co functions
(3) Trig functions of 30°, 45°, 60°
(4) Trig tables
(5) Linear interpolation
(6) Applications

Proficiencies:

Upon completion of this objective the student will be able to:

(a) define trig functions in terms of relationships between sides of a right triangle,
(b) identify co functions in right triangles,
(c) identify relationships that exist in right triangles with an acute angle equal to 30°, 45°, 60°,
(d) use trig tables for find sin, cos, or tan value for any angle,
(e) use linear interpolation,
(f) find solutions to right triangles, and
(g) use trig functions to find angle of elevation, or depression and bearing.

Evaluation:

(a) lecture notes
(b) lecture exams
(c) other methods

Reference:

Heineman,
Plane Trigonometry with Tables

Unit: Trigonometry (A2)

Objective 3: Identities

In this objective the student will learn fundamental trigonometric identities.

Specifics:

(1) Fundamental relationships
(2) Algebraic operations
(3) Proving identities

Proficiencies:

Upon completion of this objective the student will be able to:

(a) identify all eight fundamental relationships for any angle θ,
(b) follow all algebraic operations when solving equations involving trig functions,
(c) define identity,
(d) define conditional equation, and
(e) prove trig identities.

Evaluation:

(a) lecture notes
(b) lecture exams
(c) other methods

Reference:

Heineman,
Plane Trigonometry with Tables

Unit: Trigonometry (A2)

Objective 4: Angles and Radians

In this objective the student will learn related angles and the radian measurement.

Specific:

(1) Related angles
(2) Reduction
(3) Trig functions of -e
(4) The radian
(5) Length of circular arc
(6) Linear and angular velocity
(7) Trig functions of numbers

Proficiencies:

Upon completion of this objective the student will be able to:

(a) define a related angle,
(b) find the related angle for any given angle,
(c) reduce to function of an acute angle,
(d) state related-angle theorem,
(e) find the trig function for any angle $-\theta$,
(f) solve problems involving related angles and $-\theta$,
(g) define a radian,
(h) compare radians and degrees,
(i) solve problems involving radians,
(j) use radians to solve for length of a circular arc,
(k) define linear and angular velocity,
(l) use radians to solve for linear and angular velocity, and
(m) express any number as a trig function.

Evaluation:

(a) lecture notes
(b) lecture exams
(c) other methods

Reference:

Heimeman
Plane Trigonometry with Tables

Unit: Trigonometry (A2)

Objective 5: Graphs

In this objective the student will learn the graphs of the trigonometric functions.

Specifics:

(1) Periodic functions
(2) Variations of sin, cos, and tan,
(3) Graphs of the trig functions
(4) Graphs of trig identities

Proficiencies:

Upon completion of this objective the student will be able to:

(a) define periodic function,
(b) graph a periodic function,
(c) explain the variations in trig functions as angles move through different quadrants,
(d) plot the graph of the sin function,
(e) plot the cos graph,
(f) plot the tan graph,
(g) plot the cot graph,
(h) plot the sec graph,
(i) plot the csc graph,
(j) plot the graph for y = as in (bx+c), and
(k) plot the graph for y = $\sin^2 x$.

Evaluation:

(a) lecture notes
(b) lecture exams
(c) other methods

References:

Heineman,
Plane Trigonometry with Tables

Unit: Trigonometry (A2)

Objective 6: Two Angles

In this objective the student will learn trigonometric identities for functions of two angles and equations.

Specifics:

(1) Sum and difference angles
(2) Half-angle and double-angle identities
(3) Proving identities
(4) Reduction
(5) Product to sum formulas
(6) Sum to Product formulas
(7) Trig equations
(8) Identities in solving trig equations

Proficiencies:

Upon completion of this objective the student will be able to:

(a) identify sum and difference angles,
(b) prove that $\sin(A + B) = \sin A\cos B + \cos A\sin B$,
(c) prove that $\cos(A + B) = \cos A\cos B - \sin A\sin B$,
(d) solve problems using above formulas,
(e) prove that $\tan(A + B) = \dfrac{\tan A + \tan B}{1 - \tan A\tan B}$,
(f) use the above formula,
(g) prove that $\sin(A - B) = \sin A\cos B - \cos A\sin B$,
(h) prove that $\cos(A - B) = \cos A\cos B + \sin A + \sin B$,
(i) prove that $\tan(A - B) = \dfrac{\tan A + \tan B}{1 - \tan A\tan B}$,
(j) use the above formulas,
(k) reduce $a\sin\theta + b\cos\theta$ to $K\sin(Q + H)$,
(l) prove the double-angle formulas

$\sin 2A = 2\sin A\cos A$ and
$\cos 2A = \cos^2 A - \sin^2 A$,

(m) prove the half-angle formulas

$$\sin\frac{\theta}{2} = \pm\sqrt{\frac{1 - \cos\theta}{2}} \quad \text{and}$$

$$\cos\frac{\theta}{2} = \pm\sqrt{\frac{1 + \cos\theta}{2}},$$

(n) use the double-angle and half-angle formulas in problem solving,
(o) prove the various product to sum formulas,
(p) prove the various sum to product formulas,
(q) identify a trig equation, and
(r) use the various methods developed to solve trig equations.

Evaluation:

(a) lecture notes
(b) lecture exams
(c) other methods

Reference:

Heineman,
Plane Trigonometry with Tables

Unit: Trigonometry (A2)

Objective 7: Logarithms and Exponents

This objective will introduce the student to the operation of Logarithms and exponents in trigonometric equations.

Specifics:

(1) Laws of exponents,
(2) Definitions and properties of logs
(3) Graphs
(4) Common logs
(5) Tables
(6) Linear interpolation
(7) Computations
(8) Exponential and logarithmic equations
(9) The base e

Proficiencies:

Upon completion of this objective the student will be able to:

(a) state all six laws of exponents,
(b) use these laws in problem solving,
(c) define logarithms,
(d) explain $\log MN = \log M + \log N$,
(e) explain $\log M/N = \log M - \log N$,
(f) explain $\log N^k = K \log N$,
(g) use the log properties in problem solving,
(h) use exponential and logarithmic graphs,
(i) explain common logarithms,
(j) use a table of logs to find the log of any number,
(k) find nonstandard log numbers by linear interpolation,
(l) solve algebraic problem by the use of logs,
(m) solve logarithmic equations, and
(n) explain base e logarithms.

Evaluation:

(a) lecture notes
(b) lecture exams
(c) other methods

Reference:

Heineman,
Plane Trigonometry with Tables

Unit: Trigonometry (A2)

Objective 8: Triangles and Vectors

In this objective the student will learn about Triangles, Vectors and their applications.

Specifics:

(1) Solving right triangles
(2) The law of sines
(3) The law of cosines
(4) Vectors
(5) Applications of vectors

Proficiencies:

Upon completion of this objective the student will be able to:

(a) solve right triangles using trig functions,
(b) solve right triangles using log functions,
(c) state the law of sines,
(d) use the law of sines to solve oblique triangles,
(e) state the law of cosines,
(f) use the law of cosines to solve oblique triangles,
(g) define a vector,
(h) draw vector diagrams,
(i) solve for resultant, and
(j) examine the use of vectors in naxigation.

Evaluation:

(a) lecture notes
(b) lecture exams
(c) other methods

Reference:

Heieman,
Plane Trigonometry with Tables

Unit: Trigonometry (A2)

Objective 9: Inverse Trigonometric Functions

This objective will introduce the student the operation of inverse trignonmetric functions.

Specifics:

(1) Inverse trig relations
(2) Inverse trig functions
(3) Graphs
(4) Operations involving inverse trig functions

Proficiencies:

Upon completion of this objective the student will be able to:

(a) explain θ = arcsin u
(b) define the principal values of the inverse trig functions,
(c) explain arcsin, arc cos, arctan, arccot, arcsec, and arccsc,
(d) solve problems using inverse trig functions, and
(e) plot graphs of inverse trig functions.

Evaluation:

(a) lecture notes
(b) lecture exams
(c) other methods

Reference:

Heineman,
Plane Trigonometry with Tables

Unit: Trigonometry (A2)

Objective 10: Complex numbers

In this objective the student will learn the operations of complex numbers.

Specifics:

(1) Complex numbers
(2) Graphical representation
(3) Addition of complex numbers
(4) Multiplication of complex numbers
(5) DeMoivre's Theorem

Proficiencies:

Upon completion of this objective the student will be able to:

(a) identify complex numbers,
(b) explain $i^2 = -1$,
(c) present complex numbers in graphical form,
(d) use a graph to add complex numbers,
(e) explain the expression $r(\cos\theta + i\sin\theta)$,
(f) state the theorem for multiplication of complex numbers,
(g) use this theorem to solve problems,
(h) explain DeMoivre's Theorem,
(i) use DeMoivre's Theorem in problem solving.

Evaluation:

(a) lecture notes
(b) lecture exams
(c) other methods

Reference:

Heineman,
Plane Trigonometry with Tables

Unit: Basic Electricity I (B1)

Objective 1: Introduction

This objective will provide the student with a historical perspective on the field of electronics, its beginnings and present and future trends.

Specifics:

(1) Early beginnings
(2) Past
(3) Present
(4) Future

Proficiencies:

Upon completion of the objective the student will be able to:

(a) describe the origin of basic electrical terms,
(b) describe basic, fundamental electrical theories,
(c) know the originator of basic electrical theories,
(d) describe how electronics are used in our daly lives, and
(e) describe possible future uses for electronics.

Evaluation:

(a) lecture notes
(b) lecture exams

References:

Grob,
Basic Electronics

Thomson,
Fundamentals of Electronics

Unit: Basic Electricity I (B1)

Objective 2: Electricity

This objective will introduce the student to our present understanding of electricity. This understanding will be used to explain the nature, behavior, and application of electricity.

Specifics:

(a) The atom and its structure
(2) Electrical charge
(3) Potential
(4) Electrons in motion (current)
(5) Resistance
(6) The circuit
(7) Direct and alternating current
(8) Electrical sources

Proficiencies:

Upon completion of this course the student will be able to (know):

(a) composition of material,
(b) structure of all matter,
(c) describe the structure of an atom,
(d) the mass and change of an electron,
(e) charge of a proton,
(f) describe the placement of electrons in rings or shells and the valence of an atom,
(g) describe a molecule and a compound,
(h) describe the difference between conductors, insulators, and semiconductors,
(i) the difference between positive and negative polarity,
(j) which charges attract and repel,
(k) describe potential and how it is measured,
(l) describe current and its measurement,
(m) describe resistance and its measurement,
(n) describe conductance and its measurement,
(o) describe the difference between eletron flow and conventional current flow,
(p) describe the difference between direct current and alternating current, and
(q) describe different types of electrical sources.

Evaluation:

(a) lecture notes
(b) lecture exams

References:

Grob, Basic Electronics

Thomson, Fundamentals of Electronics

Unit: Basic Electricity I (B1)

Objective 3: Units and Measurements

This objective will introduce the student to the method of expressing large or small numbers in scientific notation, the process of solving problems using scientific notation, different measurement systems, and the units of measure used in electronics.

Specifics:

(1) Scientific notation
(2) Addition and subtraction
(3) Multiplication
(4) Division
(5) Mixed problems
(6) Measurement systems
(7) Electrical units of measure
(8) Unit conversions

Proficiencies:

Upon completion of this objective the student will be able to:

(a) express any number in scientific notation,
(b) add and subtract numbers in scientific notation,
(c) multiply numbers in scientific notation,
(d) divide numbers in scientific notation,
(e) express the difference between english, MKS, and CGS systems of measure,
(f) use the different levels of measure, e.g., Kilo, Micro, Giga, ect., and
(g) convert from one level of measure to another.

Evaluation:

(a) lecture notes
(b) lecture exams

References:

Grob,
Basic Electronics

Thomson,
Fundamentals of Electronics

Unit: Basic Electricity I (B1)

Objective 4: Resistance

This objective will provide the student with a more detailed study of the electrical unit resistance, and the test devices used to measure resistance.

Specifics:

(1) Conductors and resistance
(2) Conductor length and resistance
(3) Conductor cross-section and resistance
(4) Conductor material and resistance
(5) Temperature and resistance
(6) Conductor measurements
(7) Wire tables
(8) Circular mil
(9) Square mil
(10) Circular mil-square mil compared
(11) Circular mil foot
(12) Resistor types
(13) Resistor specifications and measurements

Proficiencies:

Upon completion of this objective the student will be able to:

(a) describe the difference between a conductor and a resistor,
(b) explain the relationship between conductor length and resistance,
(c) explain the relationship between conductor cross-section and resistance,
(d) describe resistivity,
(e) explain how resistivity effects resistance,
(f) explain the difference between positive and negative temperature coefficients,
(g) use an American Wire Guage table to find diameter,
(h) explain a circular mil,
(i) explain a square mil,
(j) convert from square mil to circular mil and visa versa,
(k) explain a circular mil foot and its use in determining specific resistivity,
(l) explain the difference between carbon composition, metal film, carbon film, and wire-wound resistors,
(m) determine the resistance, tolerance and wattage rating for the different types of resistors, and
(n) use the following pieces of test gear to measure resistance, VOM, VTVM, Ohmmeter, Wheatstone Bridge.

Evaluation:

(a) lecture notes
(b) lecture exams
(c) laboratory notes

(d) laboratory exams
(e) laboratory reports
(f) other methods generated by instructor

References:

Grob,
Basic Electronics

Thomson,
Fundamentals of Electronics

Kaufman & Seidman
Handbook for Electronics Engineering Technicians

Unit: Basic Electricity I (B1)

Objective 5: Series Circuits

This objective will introduce the student to the principles and behavior of a series dc circuit. Knowledge gained in previous objectives will be assumed.

Specifics:

(1) Basic concepts
(2) The series circuit
(3) Ohm's Law
(4) Oh's law in a simple series circuit
(5) Oh's law for series resistors
(6) Practical considerations
(7) Power
(8) Efficiency

Proficiencies:

Upon completion of this objective the student will be able to:

(a) measure voltage,
(b) measure current,
(c) measure resistance,
(d) express Ohm's law,
(e) determine total resistance,
(f) determine current flow in any part of a series circuit,
(g) determine polarity and voltage across any resistor,
(h) describe what effect adding or decreasing resistance will have on a circuit,
(i) describe what effect increasing or decreasing voltage will have on a circuit,
(j) explain the difference between a short or open circuit and what affect each will have,
(k) define power,
(l) calculate power,
(m) determine efficiency, and
(n) use the following pieces of test gear, VOM, VTVM, Voltmeter, Ammeter, and Ohmmeter.

Evaluation:

(a) lecture notes
(b) lecture exams
(c) laboratory notes

(d) laboratory exams
(e) laboratory reports
(f) other methods

References:

Grob,
Basic Electronics

Thomson,
Fundamentals of Electronics

Unit: Basic Electricity I (B1)

Objective 6: Parallel Circuits

This objective will introduce the student to the principles and behavior of a parallel dc circuit. Knowledge gained in previous objectives will be assumed.

Specifics:

(1) Basic Concepts
(2) Parallel circuit
(3) Two parallel resistors
(4) Three or more parallel resistors
(5) Practical considerations
(6) Power

Proficiencies:

Upon completion of this objective the student will be able to:

(a) measure voltage,
(b) measure resistance,
(c) measure current,
(d) calculate total resistance,
(e) calculate total circuit current,
(f) calculate each branch current,
(g) explain what effect adding resistance will have on the circuit,
(h) determine power, and
(i) use the following pieces of test gear, VOM, VTVM, Voltmeter, Ammeter, Ohmeter.

Evaluation:

(a) lecture notes
(b) lecture exams
(c) laboratory notes
(d) laboratory exams
(e) laobratory reports
(f) other methods

References:

Grob,
Basic Electronics

Thomson,
Fundamentals of Electronics

Unit: Basic Electricity

Objective 7: Series-Parllel Circuits

This objective will introduce the student to the principles and behavior of series-parallel dc circuits. Knowledge gained in previous objectives will be assumed.

Specifics:

(1) Basic Concepts
(2) Simplification procedures
(3) Series-Parallel circuit

Proficiencies:

Upon completion of this objective the student will be able to:

(a) identify the series and parallel elements within the circuit,
(b) simplify the series elements,
(c) simplify the parallel elements,
(d) combine the simplified series and parallel elements to find total resistance,
(e) find current flow in each circuit element,
(f) find voltage across each circuit element,
(g) measure the resistive, current, and voltage values, and
(h) use the following pieces of test gear, VOM, VTVM, Voltmeter, Ammeter, and Ohmeter.

Evaulation:

(a) lecture notes
(b) lecture exams
(c) laboratory notes
(d) laboratory exams
(e) laboratory reports
(f) other methods

References:

Grob,
Basic Electronics

Thomson,
Fundamentals of Electronics

Unit: Basic Electricity I (B1)

Objective 8: Voltage Dividers

This objective will introduce the student to a common application of the series-parallel circuit, voltage divider. It will show the student how to divide a supply voltage to obtain one or more circuit operating voltages.

Specifics:

(1) Voltage dividers
(2) Reference levels
(3) Voltage dividers under load

Proficiencies:

Upon completion of this objective the student will be able to:

(a) design a voltage divider,
(b) test voltage divider design parameters,
(c) explain a reference point as it applies to electronics,
(d) design and test a voltage divider using an arbitrary reference point,
(e) explain the operation of a voltage divider operating under a load,
(f) design & test a loaded voltage divider, and
(h) use the following pieces of test gear, VOM, VTVM, Voltmeter, and Ammeter.

Evaluation:

(a) lecture notes
(b) lecture exams
(c) laboratory notes
(d) laboratory exams
(e) laboratory reports
(f) other methods

Reference:

Grob,
Basic Electronics

Thomson,
Fundamentals of Electronics

Unit: Basic Electricity I (B1)

Objective 9: Measurement of Current

This objective will introduce the student to the principles and techniques used to measure current, basic meter movements, and how to extend the range and make multi-range ammeters.

Specifics:

(1) Basic meter movements
(2) Galvanometers
(3) Ammeters
(4) Extending ammeter range
(5) Multi-range ammeter

Proficiencies:

Upon completion of this objective the student will be able to:

(a) explain the D'Arsonval movement,
(b) explain the taut-band movement,
(c) explain the thermocouple movement,
(d) explain the operation of a Galvanometer,
(e) use a shunt to extend the range of an ammeter,
(f) calculate the value of a shunt,
(g) test the calculated shunt value,
(h) calculate the shunt values for a multi-range ammeter,
(i) test the calculated shunt values, and
(j) use the following pieces of test gear, VOM, VTVM, Voltmeter, Ammeter, and Ohmeter.

Evaluation:

(a) lecture notes
(b) lecture exams
(c) laboratory notes
(d) laboratory exams
(e) laboratory reports
(f) other methods

References:

Grob,
Basic Electronics

Thomson,
Fundamentals of Electronics

Unit: Basic Electricity I (B1)

Objective 10: Measurement of Voltage

This objective will introduce the student to the principles and techniques of measuring voltage, voltmeter sensitivity, and multi-range voltmeters.

Specifics:

(1) Voltmeters
(2) Voltmeter sensitivity
(3) Significance of voltmeter sensitivity
(4) Multi-range voltmeters

Proficiencies:

Upon completion of this course the student will be able to:

(a) describe the operation of a voltmeter,
(b) calculate the value of multiplying resistor needed for a specific voltage range,
(c) test the calculated multiplier value,
(d) explain the purpose and importance of ohms/volt rating,
(e) explain the difference between low and high sensitivity meters,
(f) demonstrate loading effect,
(g) design a multi-range voltmeter,
(h) test design parameters, and
(i) use the following pieces of test gear, VOM, VTVM, Voltmeter, and Ohmmeter.

Evaluation:

(a) lecture notes
(b) lecture exams
(c) laboratory notes
(d) laboratory exams
(e) laboratory reports
(f) other methods

References:

Grob,
Basic Electronics

Thomson,
Fundamentals of Electronics

Unit: Basic Electricity I (B1)

Objective 11: Measurement of Resistance

This objective will introduce the student to the principles and techniques of measuring resistance, different types of Ohmeter circuits, and design considerations for multimeters.

Specifics:

(1) Ohmmeters
(2) Bridges
(3) Ohmmeter applications
(4) Multimeters

Proficiencies:

Upon completion of this objective the student will be able to:

(a) explain the operation of an ohmmeter,
(b) design a simple, series ohmmeter,
(c) test the design parameters,
(d) explain the operation of a Wheatstone Bridge,
(e) design and test a Wheatstone Bridge,
(f) show how an ohmmeter can be used to check for circuit continuity, shorts, opens, and resistance values,
(g) describe the operation of a multimeter,
(h) design and test a multimeter, and
(i) use the following pieces of test gear, VOM, VTVM, Voltmeter, Ammeter, Ohmeter, and a Wheatstone Bridge.

Evaluation:

(a) lecture notes
(b) lecture exams
(c) laboratory notes
(d) laboratory exams
(e) laboratory reports
(f) other methods

References:

Grob,
Basic Electronics

Thomson,
Fundamentals of Electronics

Unit: Basic Electricity I (B1)

Objective 12: Batteries

This objective will provide the student with a more detailed description of the operation of chemical cells and batteries.

Specifics:

(1) Voltaic cells
(2) Battery
(3) Primary and secondary cells
(4) Carbon-Zinc cells
(5) Lead-Acid storage cells
(6) Other cell types
(7) Internal resistance
(8) Batteries in operation
(9) Constant current source
(10) Constant voltage source

Proficiencies:

Upon completion of this objective the student will be able to:

(a) describe an electrode,
(b) describe an electrolyte,
(c) describe the operation of a voltaic cell,
(d) describe a battery
(e) explain the differance between a primary and a secondary cell,
(f) describe the operation of a carbon-zinc cell,
(g) explain the charge and discharge cycles of lead-acid battery,
(h) give characteristics and uses for carbon-zinc, lead-acid, alkaline-maganese, mecury, edison, and nickel-cadmium cells,
(i) explain internal resistance
(j) measure internal resistance
(k) explain how the internal resistance effects battery operation,
(l) show the relationship between internal resistance and a constant voltage source or constant current source,
(m) show when maximum transfer of power occurs, and
(n) explain the operation of cells in a parallel, series aiding or series opposing circuit.

Evaluation:

(a) lecture notes
(b) lecture exams
(c) laboratory notes
(d) laboratory exams
(e) laboratory reports
(f) other methods

References:

Grob,
Basic Electronics

Thomson,
Fundamentals of Electronics

Unit: Basic Electricity II (B2)

Objective 1: Magnetism

This objective will introduce the student to the theory and help develop an understanding of the force of magnetism.

Specifics:

(1) The magnet
(2) The magnetic field
(3) Theory of magnetism
(4) Magnetic Units
(5) Magnets and magnetic materials

Proficiencies:

Upon completion of this objective the student will be able to:

(a) describe the action of magnetic poles,
(b) describe the action of magnetic lines of force,
(c) define flux,
(d) identify magnetic and non-magnetic materials,
(e) describe the affect magnetic and non-magnetic materials have on a magnetic field,
(f) work the formula $B = \frac{\phi}{A}$ in either the cgs or mks system,
(g) describe the Weber-Ewing theory,
(h) describe the magnetic field around a current-carrying conductor,
(i) describe the action of an electromagnet,
(k) explain the left-hand rule, and
(i) identify each of the following terms and their relationship to each other: Maxwell, Gilbert, Gauss, Webers, Oersted, & Tesla.

Evaluation:

(a) lecture notes
(b) lecture exams
(c) other methods

References:

Grob,
Basic Electronics

Thomson,
Fundamentals of Electronics

Unit: Basic Electricity II (B2)

Objective 2: Magnetic Circuits

This objective will introduce the student to the behavior of magnetic circuits.

Specifics:

(1) Magnetic circuits
(2) Magnetic units
(3) Magnetization curve
(4) Magnetic Hysteresis
(5) Magnetic and electric circuits compared
(6) Magnetic circuits relationships applied
(7) The motor effect
(8) Electromagnetic Induction

Proficiencies:

Upon completion of this objective the student will be able to:

(a) define magnetomotive force,
(b) explain flux density,
(c) calculate Ampere-turns,
(d) calculate B,
(e) calculate H,
(f) define permeability,
(g) use the formula U=B/H,
(h) plot and explain a magnetization curve, H versus B,
(i) explain magnetic saturation,
(j) explain hysteresis,
(k) plot and explain a hysteresis curve, B versus H,
(l) explain Ohm's Law for magnetic circuits,
(m) use the formula $\phi = m/R$,
(n) define reluctance,
(o) explain motor effect,
(p) explain and use the right-hand rule,
(q) explain electromagnetic induction,
(r) state Lenz's law,
(s) explain and use the formula $e = N\frac{d\phi}{dt}$, and
(t) setup and use a gaussmeter, galvanometer, ammeter, and voltmeter.

Evaluation:

(a) lecture notes
(b) lecture exams
(c) laboratory notes
(d) laboratory exams
(e) laboratory reports
(f) other methods

References:

Grob,
Basic Electronics

Thomson,
Fundamentals of Electronics

Unit: Basic Electricity II (B2)

Objective 3: Phasors and Vectors

This objective will introduce the student to the basic mathematical concepts needed for the study of alternating current circuits.

Specifics:

(1) Vectors
(2) Vector notation
(3) Vector representation
(4) The j operator
(5) Complex numbers
(6) Vector Addition and Subtraction
(7) Vector multiplication and division
(8) Phasors
(9) Rotating vectors
(10) Periodic functions
(11) Angular measurements
(12) Sine wave characteristics
(13) Sine wave analysis

Proficiencies:

Upon completion of this objective the student will be able to:

(a) use a vecyor to show direction and force,
(b) describe a vector with rectangular notation,
(c) describe a vector with polar notation,
(d) explain the j operator,
(e) use the j operator to describe a vector,
(f) preform vector addition,
(g) explain the use of phasors,
(h) explain a rotating vector,
(i) use a rotating vector to plot a sine curve,
(j) use a rotating vector to plot a cosine curve,
(k) calculate the instantaneous magnitude of a vector using the proper sine value,
(l) define periodic functions,
(m) define angular velocity,
(n) use the formula $y=E\sin\phi$,
(o) define a cycle,
(p) define the term Hertz (H_z),
(q) define period,
(r) use the formula $T=1/f$,
(s) define wavelength, and
(t) use the formula $\lambda=v/f$.

Evaluation:

(a) lecture notes,
(b) lecture exams,
(c) other methods.

References:

Grob,
Basic Electronics

Thomson,
Fundamentals of Electronics

Unit: Basic Electricity II (B2)

Objective 4: Alternating Current

The objective will be a fruther introduction into the basic concepts of alternatic current circuits.

Specifics:

(1) Basic Concepts
(2) Phasor representation of voltage and current
(3) AC voltage generation
(4) Average value
(5) Effective value
(6) Nonsinusoidal wave forms
(7) Phase relationships

Proficiencies:

Upon completion of this objective the student will be able to:

(a) describe an ac signal,
(b) determine the instantaneous value of voltage or current from a phasor,
(c) describe the process of generating an ac signal,
(d) identify the factors that control the amount of voltage induced during the generation of an ac signal,
(e) compute average value,
(f) compute effective value,
(g) compute peak value,
(h) compute peak-to-peak value,
(i) describe the difference between effective and rms,
(j) describe the make up of a square wave,
(k) describe the make up of a sawtooth wave,
(l) explain a phase difference,
(m) show a phase difference with a phasor, and
(n) setup and use an oscilloscope.

Evaluation:

(a) lecture notes
(b) lecture exams
(c) laboratory notes
(d) laboratory exams
(e) laboratory reports
(f) other methods

References:

Grab,
Basic Electronics

Thomson,
Fundamentals of Electronics

Unit: Basic Electricity II (B2)

Objective 5: Inductance

This objective will introduce the student to inductance and its applications.

Specifics:

(1) Induction
(2) Inductance
(3) Mutual Inductance
(4) Inductances in series or parallel
(5) Transformers
(6) Auto transformers
(7) Transformer construction
(8) Transformer Losses
(9) Transformer efficiency
(10) Transformer applications

Proficiencies:

Upon completion of this objective the student will be able to:

(a) explain induction,
(b) describe the action of storage and release of a magnetic field,
(c) explain how voltage is induced,
(d) use the formula $e=L\ di/dt$,
(e) define inductance,
(f) identify those factors that vary an inductance value,
(g) define mutual inductance,
(h) use the formula $Lt=L, +L_2 \pm 2Lm$,
(i) explain coefficient of coupling (k),
(j) use the formula $Lm=K\sqrt{L,L_2}$,
(k) make all appropriate calculations for inductors in series,
(l) make all appropriate calculations for inductors in parallel,
(m) describe a transformer,
(n) explain the operation of a step-up, or step-down transformer,
(o) work turns ratio problems,
(p) use the formula $Es/Ep=Ns/Np$,
(q) explain current ratio,
(r) calculate current requirements for multiple secondary transformers,
(s) identify and explain the losses found in a transformer,
(t) describe some typical uses for transformers, and
(u) setup and use an ammeter, voltmeter, oscilloscope, and inductance bridge for the analysis of inductive circuits.

Evaluations:

(a) lecture notes
(b) lecture exams
(c) laboratory notes
(d) laboratory exams
(e) laboratory reports
(f) other methods

References:

Grob,
Basic Electronics

Thompson
Fundamentals of Electronics

Unit: Basic Electricity II (B2)

Objective 6: Capacitance

This objective will introduce the student to capacitance and capacitor effects.

Specifics:

(1) Capacitance
(2) Charge
(3) Storage of a Charge
(4) Discharge of a Charge
(5) Units of Change
(6) Factors affecting capacitance
(7) Capacitors in series or parallel
(8) Capacitor types
(9) Capacitor identification
(10) Capacitor faults

Proficiencies:

Upon completion of this objective the student will be able to:

(a) define a charge,
(b) define capacitance,
(c) describe a capacitor,
(d) explain the charge sequence of a capacitor,
(e) explain the discharge sequence of a capacitor,
(f) explain how a capacitor holds a charge,
(g) define a coulomb (Q)
(h) use the formula Q=CE,
(i) identify and explain the factors that can vary capacitance value,
(j) define permittivity (Ke),
(k) explain dielectric strength,
(l) make all appropriate calculations for capacitors in series,
(m) make all appropriate calculations for capacitors in parallel,
(n) identify the different types of capacitors,
(o) recognize the causes of dielectric breakdown,
(p) recognize open-fault conditions with a VOM,
(q) recognize short-fault conditions with a VOM,
(r) recognize a "leaky" capacitor, and
(s) setup and use an ammeter, voltmeter, VOM, oscilloscope, and capacitance bridge for the analysis of capacitive circuits,

Evaluation:

(a) lecture notes
(b) lecture exams
(c) laboratory notes

(d) laboratory exams
(e) laboratory reports
(f) other methods

References:

Grob,
Basic Electronics

Thomson,
Fundamentals of Electronics

Unit: Basic Electricity II (B2)

Objective 7: Reactance and Impedance

This objective will introduce the student to the behavior of inductors and capacitors when placed in an ac circuit. It will also introduce the student to the behavior of resistance and reactance in an ac circuit.

Specifics:

(1) Reactance
(2) Inductive reactance
(3) Capacitive reactance
(4) Inductive reactance in series or parallel
(5) Capacitive reactance in series or parallel
(6) Impedance
(7) Applications

Proficiencies:

Upon completion of this objective the student will be able to:

(a) define reactance,
(b) use the formula $X_l = 2\pi fl$,
(c) use the formula $Xc = \frac{1}{2}\pi fC$,
(d) explain how reactance varies for changing circuit conditions,
(e) explain how reactance varies with frequency,
(f) make all necessary calculations for series reactive circuits,
(g) make all necessary calculations for parallel reactive circuits,
(h) define impedance,
(i) identify uses for reactive circuits, and
(j) setup and use an ammeter, voltmeter, VOM, oscilloscope, and function generator for the analysis of reactive circuits.

Evaluation:

(a) lecture notes
(b) lecture exams
(c) laboratory notes
(d) laboaratory exams
(e) laboratory reports
(f) other methods

References:

Grob,
Basic Electronics

Thomson,
Fundamentals of Electronics

Unit: Basic Electricity III (B3)

Objective 1: Kirchoff's Laws

This objective will introduce the student Kirchoff's Laws and their use in circuit analysis.

Specifics:

(1) Kirchoff's frist law
(2) Kirchoff's second law
(3) Convention and notation
(4) Applications
(5) Network analysis

Proficiencies:

Upon completion of this objective the student will be able to:

(a) explain Kirchoff's current law,
(b) explain Kirchoff's voltage law,
(c) describe an IR drop,
(d) describe how current flows,
(e) explain direction of current flow,
(f) explain the polarity of a source of emf,
(g) explain the affect source resistance has on an emf,
(h) describe a constant current source,
(i) describe a constant voltage source,
(j) analyze circuits by the loop current method,
(k) analyze circuits by the mesh current method,
(l) analyze circuits by the node voltage method, and
(m) setup and use an ammeter, voltmeter, VOM, and ohmmeter for the analysis of circuits.

Evaluation:

(a) lecture notes
(b) lecture exams
(c) laboratory notes
(d) laboratory exams
(e) laboratory reports
(f) other methods

References:

Grob,
Basic Electronics

Thomson
Fundamentals of Electronics

Unit: Basic Electricity III (B3)

Objective 2: Complex Circuit Analysis

This objective will introduce the student to the methods used in the analysis of complex circuits.

Specifics:

(1) Superposition theorem
(2) Thevenin's theorem
(3) Norton's theorem
(4) Thevenin's and Norton's circuit equivalence
(5) Circuit transformations

Proficiencies:

Upon completion of this objective the student will be able to:

(a) use the superposition theorem to analyze a circuit with more than one voltage source,
(b) use Thevenin's theorem to reduce a complex circuit to one voltage source with one series resistance,
(c) use Norton's theorem to reduce a complex circuit to one current source with one parallel resistance,
(d) convert a Thevenin's equivalent circuit to a Norton's equivalent circuit,
(e) convert a Norton's equivalent circuit to a Thevenin's equivalent circuit,
(f) convert a delta network to a Wye network,
(g) convert a Wye network to a delta network, and
(h) setup and use an ammeter, voltmeter and VOM in the analysis of complex circuits.

Evaluation:

(a) lecture notes
(b) lecture exams
(c) laboratory notes
(d) laboratory exams
(e) laboratory reports
(f) other methods

References:

Grob,
Basic Electronics

Thomson,
Fundamentals of Electronics

Unit: Basic Electricity III(B3)

Objective 3: Time Constants

This objective will introduce the student to the operation of Resistive/Inductive (RL) and Resistive/Capacitive (RC) combinations in a direct current circuit.

Specifics:

(1) Time in a resistive circuit
(2) Time in an RL circuit
(3) Characteristics of an RL circuit
(4) RL circuit waveforms
(5) Time in an RC circuit
(6) Characteristics of an RC circuit
(7) RC circuit waveforms
(8) Universal time constant curves
(9) Time constant effects on waveforms

Proficiencies:

Upon completion of this objective the student will be able to:

(a) explain electrical responce in a resistive circuit,
(b) explain electrical responce in an RL circuit,
(c) describe operation of an RL circuit,
(d) calculate time constant in an RL circuit,
(e) calculate steady state condition in an RL circuit,
(f) calculate instantaneous values from turn on to steady state,
(g) calculate decay current in an RL circuit,
(h) define inductive Kick,
(i) calculate inductive Kick voltage,
(j) explain electrical responce in an RC circuit,
(k) describe the operation of an RC circuit,
(l) calculate time constant in an RC circuit,
(m) calculate steady state conditions in an RC circuit,
(n) calculate instantaneous values from turn on to steady state,
(o) calculate decay voltage in an RC circuit,
(p) define capacitive Kick,
(q) calculate capacitive Kick current,
(r) plot a universal time constant curve,
(s) use a universal time constant curve to determine instantaneous charge or discharge values,
(t) explain the waveform produced by an integrator,
(u) explain the waveform produced by a differentiator, and
(v) setup and use an ammeter, voltmeter, VOM, oscilloscope, and function generator in the analysis of RL and RC dc circuits.

Evaluation:

(a) lecture notes
(b) lecture exams
(c) laboratory notes
(d) laboratory exams
(e) laboratory reports
(f) other methods

References:

Grob,
Basic Electronics

Thomson,
Fundamentals of Electronics

Unit: Basic Electricity III (B3)

Objective 4: Series Alternating Current Circuits

This objective will introduce the student to the operation of series ac circuits that contain resistance, inductance, and capacitance.

Specifics:

(1) Circuits containing only R
(2) Power in circuits containing only R
(3) Circuits containing only L
(4) Power in circuits containing only L
(5) Circuits containing only C
(6) Power in circuits containing only C
(7) Circuits containing R and L
(8) Circuits containing R and C
(9) Circuits containing R,L, and C
(10) Power in ac series circuits
(11) Resonance in a series circuits

Proficiencies:

Upon completion of this objective the student will be able to:

(a) calculate total opposition to current flow in each type of circuit,
(b) express this opposition in rectangular and polar coordinates,
(c) calculate the apparent power in each type of circuit,
(d) calculate true power in each type of circuit,
(e) calculate phase angle in each type of circuit,
(f) determine whether or not a circuit is in resonance,
(g) calculate resonant frequency for a series RCL circuit,
(h) calculate the quality of a resonant network, and
(i) setup and use an ammeter, voltmeter, VOM, oscilloscope, and function generator for the analysis of series ac circuits.

Evaluation:

(a) lecture notes
(b) lecture exams
(c) laboratory notes
(d) laboratory exams
(e) laboratory reports
(f) other methods

References:

Grob,
Basic Electronics

Thomson,
Fundamentals of Electronics

Unit: Basic Electricity III (B3)

Objective 5: Parallel Alternating Current Circuits

This objective will introduce the student to the operation of parallel ac circuits that contain resistance, inductance, and capacitance.

Specifics:

(1) Circuits containing only R
(2) Circuits containing only L
(3) Circuits containing only C
(4) Circuits containing R and L
(5) Circuits containing R and C
(6) Circuits containing R,L, and C
(7) Power in parallel ac circuits
(8) Resonance in parallel ac circuits

Proficiencies:

Upon completion of this objective the student will be able to:

(a) calculate total opposition to current flow in each type of circuit,
(b) express this opposition in either rectangular or polar coordinates,
(c) calculate apparent power in each type of circuit,
(d) calculate true power in each type of circuit,
(e) calculate phase angle in each type of circuit,
(f) determine whether or not a circuit is in resonance,
(g) calculate resonant frequency for a parallel RCL circuit,
(h) calculate the quality of a resonant network, and
(i) setup and use an ammeter, voltmeter, VOM, oscilloscope, and function generator for the analysis of parallel ac circuits.

Evaluation:

(a) lecture notes
(b) lecture exams
(c) laboratory notes
(d) laboratory exams
(e) laboratory reports
(f) other methods

References:

Grob,
Basic Electronics

Thomson,
Fundamentals of Electronics

Unit: Basic Electricity III (B3)

Objective 6: Filters

This objective will introduce the student to the types, characteristics, and operation of different filter networks.

Specifics:

(1) Basic circuit characteristics
(2) Circuits containing both AC and DC
(3) Reference levels
(4) Capacitive coupling
(5) Transformer coupling
(6) By passing
(7) Filter types
(8) Low-pass filters
(9) High-pass filters
(10) Band-pass filters
(11) Circuit considerations
(12) Resonant filters
(13) Filter applications

Proficiencies:

Upon completion of this objective the student will be able to:

(a) define a filter,
(b) explain how ac and dc can be superimposed,
(c) explain reference level,
(d) explain what is meant by current "mirrors",
(e) describe the operation of a coupling capacitor,
(f) calculate the value of a coupling capacitor,
(g) describe the operation of transformer coupling,
(h) describe the basic procedures used in the design of a coupling transformer,
(i) describe a by pass capacitor,
(j) calculate the value of a by pass capacitor,
(k) explain the operation of a low-pass filter,
(l) explain the operation of a high-pass filter,
(m) explain the operation of a band-pass filter,
(n) explain the operation of a band-reject filter,
(o) describe frequency responce in a filter,
(p) classify filters by their arrangement of internal components, and
(q) set up and use an ammeter, voltmeter, VOM, oscilloscope, function generator, and sweep generator for the analysis of filter circuits.

Evaluation:

(a) lecture notes
(b) lecture exams
(c) laboratory notes
(d) laboratory exams
(e) laboratory reports
(f) other methods

References:

Grob,
Basic Electronics

Thomson,
Fundamentals of Electronics

Unit: Basic Electronics I (B4)
Objective 1: Elementary Semiconductor Theory

This objective will introduce the student to the basic structure of semi conductor materials, basic physics of semi semiconductors, and how different types of materials are produced.

Specifics:

(1) Atomic Structure
(2) Energy bands
(3) Doping
(4) n-Type Silicon
(5) p-Type Silicon

Proficiencies:

Upon completion of this objective the student will be able to:

(a) describe the structure of semi conductive material
(b) describe how majority and minority carriers flow through a semi conductive material, and
(c) describe the doping procedures that produce n-type and p-type semiconductors.

Evaluation:

(a) lecture notes
(b) lecture exams
(c) laboratory notes
(d) laboratory exams
(e) laboratory reports
(f) other methods generated by instructor

References:

Malvino,
Electronic Principles

Kaufman & Seidman
Handbook for Electronics Engineering Technicans

Unit: Basic Electronics I (B4)
Objective 2: Junction Diode

This objective will introduce the student to the basic structure and operational characteristics of the junction diode, and its uses within different circuits.

Specifics:

1. Diode Characteristics
2. Rectifier, RF, and Switching diodes
3. Diode Parameters

Proficiencies:
Upon completion of this objective the student will be able to:

a. describe the operation of an np junction,
b. explain the difference between forward-biased and reverse-biased junctions,
c. describe the voltampere characteristics of an ideal diode and a second approximation diode,
d. explain how a diode may be used for rectification, detection, or as a DC switch, and
e. describe each of the follwing terms: forward voltage, forward current, reverse voltage, reverse current, reverse breakdown voltage, and power dissipation.

Evaluation:

a. lecture notes
b. lecture exams
c. laboratory notes
d. laboratory exams
e. laboratory reports
f. other methods generated by instructor

References:

Malvino,
Electronic Principles

Kaufman & Seidman
Handbook for Electronics Engineering Technicians

Unit: Basic Electronics I (B4)
Objective 3: Zener Diodes

This objective will introduce the student to the zener diode, its operational characteristics, and its uses in different circuits.

Specifics:

1. Zener and Avalanche breakdown
2. Regulator and reference diodes
3. Zener diode parameters

Proficiencies:
Upon completion of this objective the student will be able to:

a. describe the operation of a zener diode,
b. explain the difference between a forward-biased and a reversed-biased zener diode,
c. explain the zener knee,
d. explain how a zener diode may be used for voltage regulation or as a reference voltage source, and
e. describe each of the following terms: zener voltage, zener knee current, maximum zener current, and power dissipation.

Evaluation:

a. lecture notes
b. lecture exams
c. laboratory notes
d. laboratory exams
e. laboratory reports
f. other methods generated by instructor

References:

Malvino,
Electronic Principles

Kaufman Seidman
Handbook for Electronics Engineering Technicians

Unit: Basic Electronics I (B4)
Objective 4: Bipolar Junction Transistor (BJT)

This objective will introduce the student to the bipolar junction transistor, methods of biasing the transistor, its family of curves, and its operational parameters.

Specifics:

1. operation
2. reverse-reverse bias
3. forward-forward bias
4. reverse-forward bias
5. biasing networks
6. characteristic curves
7. parameters

Proficiencies:
Upon completion of this objective the student will be able to:

a. describe the operation of a BJT,
b. use a family of curves to determine saturation current, cutoff voltage, quiescent current, and Quiescent voltage for each of the following biasing networks, voltage divider, base bras, collector feedback, and emitter bias, and
c. know the meaning of, and symbol for each of the follwoing terms, alpha, beta, collector current, base current, emitter current, collector voltage, base voltage, emitter voltage, collector-emitter voltage, collector cutoff voltage, collector saturation current, collector-base voltage (emitter open), emitter-base voltage (collector open), small signal forward current gain, DC forward current gain, and collector dissipation.

Evaluation:

a. lecture notes
b. lecture exams
c. laboratory notes
d. laboratory exams
e. laboratory reports
f. other methods generated by instructor

References:

Malvino,
Electronic Principles

Kaufman & Seidman
Handbook for Electronics Engineering Technicians

Unit: Basic Electronics I (B4)
Objective 5: Field Effect Transistors (FET)

This objective will introduce the student to the junction field effect transistor, metal-oxide semiconductor field effect transistor (MOSFET), methods of biasing, its family of curves, and its operational characteristics.

Specifics:

1. junction FET
2. operation
3. biasing networks
4. MOSFET
5. depletion mode operation
6. enhancement mode operation
7. parameters
8. family of curves

Proficiencies:
Upon completion of this objective the student will be able to:

a. describe the operation of the junction FET,
b. describe the operation of depletion mode and enhancement made MOSFET'S,
c. use a family of curves to determine saturation current, cutoff voltage, Quiescent current and Quiescent voltage for each of the following biasing networks, self bias, emitter-source bias, and
d. know the meaning of, and symbol for each of the following terms, source current, drain current, zero bias drain current, pinchoff voltage, gate-source reverse breakdown voltage, and forward transconductance.

Evaluation:

a. lecture notes
b. lecture exams
c. laboratory notes
d. laboratory exams
e. laboratory reports
f. other methods generated by instructor

References:

Malvino,
Electronic Principles

Kaufman & Seidman
Handbook for Electronics Engineering Technicians

Unit: Basic Electronics I (B4)
Objective 6: Silicon-Controlled Rectifier (SCR)

This objective will introduce the student to the operation, characteristics, and parameters of an SCR.

Specifics:

1. structure
2. biasing
3. gate trigger current
4. operation
5. characteristics
6. parameters

Proficiencies:
Upon completion of this objective the student will be able to:

a. describe the operation of an SCR,
b. determine trigger current for a given gate voltage from the characteristic curves, and
c. know the meaning of, and symbol for each of the follwoing terms, forward breakdown voltage, reverse breakdown voltage, turn-on voltage, turn-on current, holding current, latching current, gate trigger current, and gate trigger voltage.

Evaluation:

a. lecture notes
b. lecture exams
c. laboratory notes
d. laboratory exams
e. laboratory reports
f. other methods generated by instructor

References:

Malvino,
Electronic Principles

Kaufman & Seidman
Handbook for Electronics Engineering Technicians

Unit: Basic Electronics I (B4)
Objective 7: Other Semiconductor Devices

This objective will introduce the student to the operational characteristics of other forms of semiconductive devices.

Specifics:

1. light-Activated SCR
2. Light-Emitting diode
3. Tunnel diode
4. Schottky barrier diode
5. Photodiode
6. Phototransistor
7. Opto-Isolator
8. Microwave power-diode

Proficiencies:
Upon completion of this objective the student will be able to:

a. describe the operation of and give characteristics of each of the afore mentioned devices.

Evaluation:

a. lecture notes
b. lecture exams
c. laboratory notes
d. laboratory exams
e. laboratory reports
f. other methods generated by instructor

References:

Malvino,
Electronic Principles

Kaufman & Seidman
Handbook for Electronics Engineering Techicians

Unit: Basic Electronics I (B4)
Objective 8: Classification of Amplifiers

This objective will introduce the student to the different classes of amplifier circuits, and their uses.

Specifics:

1. class A
2. class B
3. class AB_1
4. class AB_2
5. class C

Proficiencies:
Upon completion of this objective the student will be able to:

a. describe signal flow patten through each class of amplifier,
b. plot bias point and signal pattern on an IpEg curve for each class of amplifier, and
c. determine which class of amplifier to use when given a set of conditions.

Evaluations:

a. lecture notes
b. lecture exams
c. laboratory notes
d. laboratory exams
e. laboratory reports
f. other methods generated by instructor

References:

Malvino,
Electronic Principles

Kaufman & Seidman
Handbook for Electronics Engineering Technicians

Unit: Basic Electronics I (B4)
Objective 9: Amplifier Characteristics

This objective will introduce the student to the various characteristics of amplifiers.

Specific:

1. voltage gain
2. current gain
3. power gain
4. input resistance
5. output resistance
6. bandwidth
7. harmonic distortion
8. intermodulation distortion
9. slewing rate

Proficiencies:
Upon completion of this objective the student will be able to:

a. measure and/or calculate the voltage, current, and power gain of a given amplifier circuit,
b. determine input and putput resistance for a given amplifier circuit,
c. determine band width when given the - 3dB frequencies,
d. recognize the different distortion types fromand oscillograph, and
e. calculate slew rate.

Evaluation:

a. lecture notes
b. lecture exams
c. laboratory notes
d. laboratory exams
e. laboratory reports
f. other methods generated by instructor

References:

Malvino,
Electronic Principles

Kaufman & Seidman
Handbook for Electronics Engineering Technicians

Unit: Basic Electronics II (B5)
Objective 1: Audio Circuits

This objective will introduce the student to the various types of audio circuits, their operational characteristics, analytical procedures for testing these circuits, typical problems encountered, and use of the various pieces of test equipment needed to a alyze these circuits.

Specifics:

1. Pre-Amps
2. Push-Pull
3. Phase Splitter
4. Distortion
5. Negative Feedback
6. Stereophonic Sound

Proficiencies:
Upon completion of this objective, the student will be able to:
(a) recognize the types and classes of audio amplifiers from schematic diagrams,
(b) describe the operation of the various types and classes of audio amplifiers, and
(c) set up and operate the following pieces of test gear: voltmeter, ammeter, oscilliscope, distortion analyzer, and function generator.

Evaluation:
(a) lecture notes
(b) lecture exams
(c) laboratory exams
(d) laboratory notes
(e) laboratory reports
(f) other methods generated by instructor

Reference:

Malvino,
Electronic Principles

Unit: Basic Electronics II (B5)
Objective 2: Radio Frequency Circuits

This objective will introduce the student to the various types of radio frequency (RF) circuits, their operational characteristics, analytical procedures for testing these circuits, typical problems encountered, and use of the various pieces of test equipment needed to analyze these circuits.

Specifics:

1. RF Amps
2. Single tuned
3. Double tuned
4. Stopper tuned
5. Wave traps
6. Wide band

Proficiencies:
Upon completion of this objective, the student will be able to:

(a) recognize the types and classes of RF amplifiers from schematic diagrams,
(b) describe the operation of the various types and classes of RF amplifiers, and
(c) set up and operate the following pieces of test gear: voltmeter, ammeter, oscilliscope, distortion analyzer, sweep generator, and function generator.

Evaluation:

(a) lecture notes
(b) lecture exams
(c) laboratory exams
(d) laboratory notes
(e) laboratory reports
(f) other methods generated by instructor.

Reference:

Malvino,
Electronic Principles

Unit: Basic Electronics II (B5)
Objective 3: Oscillators

This objective will introduce the student to the various types of oscillator circuits, their operational characteristics, analytical procedures of testing these curcuits, typical problems encountered, and the use of the various pieces of test equipment used in testing these circuits.

Specifics:

1. Hartley
2. Colpitts
3. Tuned grid
4. Crystal
5. Resonant Lines
6. Wave guides
7. Ulystrons
8. Lasers
9. Masers

Proficiencies:
Upon completion of this objective the student will be able to:

a. recognize the various types of oscillator circuits from schematic diagrams
b. describe the operational chacteristics of the various types of oscillator circuits, and
c. set up and operate the following pieces of test gear, Voltmeter, Ammeter, Oscilloscope, Distortion Analizer, and Frequency counter.

Evaluation:

a. lecture notes
b. lecture exams
c. laboratory exams
d. laboratory notes
e. laboratory reports
f. other methods generated by instructor

Reference:

Malvino,
Electronic Principles

Unit: Basic Electronics II (B5)
Objective 4: Power Supplies

This objective will introduce the student to the various types of rectifiers and power supply circuits, their operational characteristics, analytical procedures for testing these circuits, typical problems encountered, and the various pieces of test equipment used in testing these circuits.

Specifics:

1. Rectifiers
2. Bridges
3. Voltage doublers
4. Filters
5. Voltage regulators
6. Converters & inverters

Proficiencies:
Upon completion of this objective the student will be able to:

a. recognize the various types of rectifiers and power supply circuits from schematic diagrams,
b. describe the operational characteristics of the various types of rectifiers and power supplies, and
c. Set up and use the following pieces of test equipment, Voltmeter, Ammeter, Oscilloscope.

Evaluation:

a. lecture notes
b. lecture exams
c. laboratory notes
d. laboratory exams
e. laboratory reports
f. other methods generated by instructor

Reference:

Malvino,
Electronic Principles

Unit: Communication Techniques (B6)
Objective 1: Modulation

This objective will introduce the student to the various methods of modulating an RF carrier, the relative advantages and disadvantages of each method, test methods to insure that modulation parameters are not exceeded, the necessary test equipment needed to make modulation adjustments, and typical problems encountered with these circuits.

Proficiencies:
Upon completion of this objective the student will be able to:

a. recognize the various types of modulation circuits from schematic diagrams,
b. describe the various methods of modulating a carrier,
c. recognize possible faults for a set of symtoms in a modulating circuit, and
d. set up and operate the following pieces of test equipment, Distortion analizer, function generator, and an oscilloscope.

Evaluation:

a. lecture notes
b. lecture exams
c. laboratory notes
d. laboratory exams
e. laboratory reports
f. other methods generated by instructor

Reference:

Mendl,
Principles of Electronic Communications

American Radio Relay League
Radio Amateur Handbook

Schrader,
Electronic Communications

Unit: Communication Techiques (B6)
Objective 2: Transmitters

This objective will introduce the student to the radio frequency transmitter, the different types of RF transmitters, methods of changing transmitter frequency, increasing transmitter power, the proper method of adjusting a transmitter, typical problems encountered, and the test equipment needed to isolate faults.

Specifics:

1. Oscillator transmitter
2. Power amplifier
3. Master Oscillator Power Amplifier
4. Heterodyning tansmitter
5. Frequency multipliers
6. Power tubes

Proficiencies:
Upon completion of this objective the student will be able to:

a. recognize different types of transmitter circuits from schematic diagrams,
b. describe the tuning and operational characteristics of the different types of transmitter circuits,
c. isolate faults given a set of meter readings from within a transmitter circuit, and
d. Set up and operate the following pieces of test equipment, Voltmeter, Ammeter, Oscilloscope, and Frequency counter.

Evaluation:

a. lecture notes
b. lecture exams
c. laboratory notes
d. laboratory exams
e. laboratory reports
f. other methods generated by instructor

References:

Mandl,
Priciples of Electronic Communications

American Radio Relay League
The Radio Amateur Handbook

Schrader,
Electronic Communications

Unit: Communication Techniques (B6)
Objective 3: Antennas

This objective will introduce the student to the radiation of electromagnetic waves, the make up of an electromagnetic wave, how these waves are propagated, the different types of antennas, and the methods of transfering a signal from a transmitter to an antenna.

Specifics:

1. E-H waves
2. Radiation
3. Propagation
4. Antenna types
5. Transmission Lines
6. UHF waveguides

Proficiencies:
Upon completion of this objective the student will be able to:

a. describe the make up of an electromagnetic wave
b. describe the difference between vertical, horizontal,and circularly polarized waves,
c. describe the typical propagation pattern for electromagnetic waves from medium frequencies through extremely high frequencies,
d. design and describe the operation of a dipole, Yagi, Quad, and parabolic reflector antenna,
e. describe the difference between open-line, coaxial, and waveguide feed system, and
f. determine when the different types of antennas and feed systems should be used.

Evaluation:

a. lecture notes
b. lecture exams
c. laboratory notes
d. laboartory exams
e. laboaratory reports
f. other methods generated by instructor

References:

Mendl,
Principles of Electronic Communications

American Radio Relay League
The Radio Amateur Handbook

Schrader,
Electronics Communications

Unit: Communication Techniques (B6)
Objectives 4: Principles of Receivers

This objective will introduce the student to the basic principles behing the recovery of audio information from an RF carrier, basic forms of receivers, typical problems encountered, and the test equipment used in isolating faults.

Specifics:

1. Detector
2. Tuned Radio Frequency
3. Regenerative
4. Superheterodyne
5. Single conversion
6. Dual Conversion

Proficiencies:
Upon completion of this objective the student will be able to:

a. recognize the various types of receivers from their schematic diagram,
b. describe the operational characteristics of each type of receiver,
c. indicate possible problems for a given set of symptoms, and
d. set up and operate the following pieces of test gear, Voltmeter, Ammeter, Oscilloscope, and Function generator.

Evaluation:

a. lecture notes
b. lecture exams
c. laboratory notes
d. laboratory exams
e. laboratory reports
f. other methods generated by instructor

References:

Mandl,
Principles of Electronic Communications

American Radio Relay League
Radio Amateur Handbook

Schrader,
Electronic Communications

Unit: Communication Techniques (B6)
Objective 5: Receiver Circuits

This objective will introduce the student to the different types of circuits used within a receiver, their operational characteristics, their function within a receiver, typical problems encountered, and the test equipment used in isolating faults.

Specifics:

1. AD/DC
2. AM and FM detectors
3. Intermidiate Frequency Amplifiers
4. Automatic Volume control (AVC)
5. Automatic Gain Control (AGC)
6. Limiters
7. Discriminators
8. FM Stereo Multiplexing
9. TV receivers

Proficiencies:
Upon completion of this objective the student will be able to :

a. recognize the various receiver circuits from their schematic diagram,
b. describe the function and operational characteristics for each circuit,
c. recognize possible faults for a given set of symptoms, and
d. setup and operate the following pieces of test equipment, Voltmeter, Ammeter, Oscilloscope, Distortion Analyzer, Sweep generator, and Function generator.

Evaluation:

a. lecture notes
b. lecture exams
c. laboratory notes
d. laboratory exams
e. laboratory reports
f. other methods generated by instructor

References:

Mandl,
Principles of Electronic Communications

Schrader,
Electronic Communications

American Radio Relay League
Radio Amateur Handbook

Unit: Laser Safety (C1)

Objective 1: Introduction

This objective will introduce the student to Laser Safety and the hazards associated with lasers.

Specifics:

(1) Concern
(2) Protective standard for eye and skin exposure
(3) Evaluation and control of the laser hazard

Proficiencies:

Upon completion of this objective the student will be able to:

(a) identify the properties of a laser that may cause damage to a person if not handled properly,
(b) describe the protective standards for the eye,
(c) describe possible damage if the protective standards are not followed,
(d) describe the protective standards for the skin,
(e) describe possible damage if the protective standards are not followed,
(f) evaluate laser hazards, and
(g) recommend controls for reducing laser hazards.

Evaluation:

(a) lecture notes
(b) lecture exams
(c) other methods

Reference:

Mallow and Chabot,
Laser Safety Handbook

Unit: Laser Safety (C1)

Objective 2: Biological Effects

This objective will introduce the student to the biological effects of laser radiation.

Specifics:

(1) The eye
(2) Tissue damage mechanisms
(3) Factors contributing to tissue damage
(4) The eye hazard
(5) The skin hazard

Proficiencies:

Upon completion of this objective the student will be able to:

(a) provide a description of the eye,
(b) describe thermal, photochemical, acoustic transients, chronic exposure, and other phenomena that cause tissue damage,
(c) describe those factors that cause tissue damage,
(d) identify specific biological effects to the skin.

Evaluation:

(a) lecture notes
(b) lecture exams
(c) other methods

Reference:

Mallow and Chabot,
Laser Safety Handbook

Unit: Laser Safety (C1)

Objective 3: Associated Hazards

This objective will introduce the student to associated laser hazards.

Specifics:

(1) Electrical hazards
(2) Airborne contaminants
(3) Cryogenic liquids
(4) Noise hazards
(5) Ionizing radiation
(6) Non-laser beam optical radiation hazard
(7) Explosion hazard
(8) Fire hazard

Proficiencies:

Upon completion of this objective the student will be able to:

(a) identify the factors that influence electrical shock,
(b) recognize the physiological effects of shock,
(c) identify toxic contaminants generated by laser use,
(d) identify safety standards associated with airborne materials,
(e) identify hazards associated with cryogenic systems, and
(f) recognize hazards associated with noise, ionization, ultraviolet radiation, explosion, and fire.

Evaluation:

(a) lecture notes
(b) lecture exams
(c) other methods

Reference:

Mallow and Chabot,
Laser Safety Handbook

Unit: Laser Safety (C1)

Objective 4: Protective Standards

This objective will introduce the student to the protective standards associated with maximum permissible exposure.

Specifics:

(1) Intrabeam and extended source exposure conciderations,
(2) Intra-beam viewing-maximum permissible exposure,
(3) Extended source viewing - maximum permissible exposure,
(4) Maximum permissible exposure (MPE) for skin,
(5) MPE correction factors and special handling techniques - visible and near infrared,
(6) Determination of MPE for repetitively pulsed lasers,
(7) MPE correction factors - infrared, and
(8) Formulas, considerations and examples useful in exaluation of various laser applications.

Proficiencies:

Upon completion of this objective the student will be able to:

(a) identify diagrams and symbols used in determining maximum permissible exposure,
(b) describe intrabeam viewing,
(c) describe extended source viewing,
(d) use the appropriate formulas for determining maximum permissible exposure,
(e) employ the necessary correction factors for different type lasers,
(f) determine maximum permissible exposure for pulsed lasers, and
(g) make evaluation of laser applications.

Evaluation:

(a) lecture notes
(b) lecture exams
(c) other methods

Reference:

Mallow and Chabot
Laser Safety Handbook

Unit: Laser Safety (C1)

Objective 5: Evaluation and Classification

This objective will introduce the student to the methods used in laser beam hazard evaluation and classification.

Specifics:

(1) Laser classification considerations
(2) Laser classification definitions
(3) Central beam irradiance or radiant exposure
(4) Examples of laser classifications
(5) The laser environment
(6) The personnel present in the laser environment

Proficiencies:

Upon completion of this objective the student will be able to:

(a) know when a change in classification may be required,
(b) identify circumstances that may cause a change in classification,
(c) identify the parameters of a Class I Laser,
(d) identify the parameters of a Class II Laser,
(e) identify the parameters of a Class III Laser,
(f) identify the parameters of a Class IV Laser,
(g) calculate beam irradiance,
(h) calcualte radiant exposure,
(i) use beam irradiance and radiant exposure when determining classification and maximum permissible exposure,
(j) assess environmental conditions when determining laser beam hazard, and
(k) consider the personnel present when determining the laser beam hazard.

Evaluation:

(a) lecture notes
(b) lecture exams
(c) other methods

Reference:

Mallow and Chabot
Laser Safety Handbook

Unit: Laser Safety (C1)

Objective 6: Control

This objective will introduce the student to the methods used in the control of laser beam hazard.

Specifics:

(1) Class I - exempt laser control measures
(2) Class II - low power laser control measures
(3) Class III - medium power laser control measures
(4) Class IV - high power laser control measures
(5) Class V - enclosed laser control measures
(6) Infrared lasers - special control measures
(7) Ultraviolet lasers - special control measures
(8) Warning signs and lables

Proficiencies:

Upon completion of this objective the students will be able to:

(a) identify the control measures for Class I Lasers,
(b) identify the control measures for Class II Lasers,
(c) identify and desvirbe all categories of control measures for Class III Lasers,
(d) identify and describe all categories of control measures for Class IV Lasers,
(e) identify the control measures for Class V Lasers,
(f) identify and describe all categories of control measures for infrared lasers,
(g) identify and describe all categories of control measures for ultraviolet lasers,
(h) identify and describe the following parts of laser warning signs: laser hazard symbol, signal words, pertinent information, how signs are displayed, and the design of signs, and
(i) recognize laser classification from warning signs.

Evaluation:

(a) lecture notes
(b) lecture exams
(c) other methods

Reference:

Mallow and Chabot
Laser Safety Handbook

Unit: Laser Safety (C1)

Objective 7: Control of associated hazards

This objective will introduce the student to the methods used in the control of associated laser hazards.

Specifics:

(1) Control of electrical hazard
(2) Control of airborne contaminants
(3) Control of cryogenic liquid hazards
(4) Control of noise hazards
(5) Control of ionizing radiation hazards
(6) Control of non-laser beam optical radiation hazards
(7) Control of explosion hazards
(8) Control of fire hazards

Proficiencies:

Upon completion of this objective the student will be able to:

(a) identify safety regulations dealing with electrical safety,
(b) recognize general safety precautions,
(c) describe first aid procedures for electrical shock victims,
(d) control airborne contaminants through ventilation,
(e) use or be familiar with contaminant detection equipment,
(f) use respirator protective devices,
(g) follow safety guide lines when working around cryogenic liquids,
(h) follow hearing conservation measures,
(i) use proper sheilding for protection against ionizing radiation and non-laser beam optical radiation hazard,
(j) inspect lasers to ensure that explosion proof housings are in place, and
(k) find and use appropriate fire fighting equipment.

Evaluation:

(a) lecture notes
(b) lecture exams
(c) other methods

References:

Mallow and Chabot
Laser Safety Handbook

Unit: Laser Safety (C1)

Objective 8: Safety Program

This objective will introduce the student to the Laser Safety Program used in the classroom.

Specifics:

(1) General guidelines
(2) Safety aids
(3) Personnel risk classification
(4) Types of eye examinations
(5) Skin surveillance requirements
(6) Medical examination requirements
(7) Frequency of medical examinations

Proficiencies:

Upon completion of this objective the student will be able to:

(a) identify the responcible authority in the laser lab,
(b) describe all safety guidelines,
(c) never work alone,
(d) use a beam shutter,
(e) provide a proper target for the beam,
(f) follow safety guidelines when providing demonstration or conducting experiments,
(g) identify minimal, moderate, and high risk personnel,
(h) describe a typical eye examination,
(i) describe skin surveillance requirements,
(j) identify medical examination rquirements for each personnel risk category, and
(k) identify when medical examinations should occur.

Evaluation:

(a) lecture notes
(b) lecture exams
(c) other methods

Reference:

Mallow and Chabot
Laser Safety Handbook

Unit: Laser Safety (C1)

Objective 9: Protective Eyewear

This objective will introduce the student to the methods for selecting and proper use of laser protective eyewear.

Specifics:

(1) Factors in selecting protective eyewear
(2) Identification of eyewear
(3) Inspection of eyewear
(4) Types of protective eyewear
(5) Responsibility of manufacturer
(6) Broadband development

Proficiencies:

Upon completion of this objective the student will be able to:

(a) identify and describe those factors used in the selection of protective eyewear,
(b) recognize labeling on eyewear so as to know which laser systems they can and cannot be used,
(c) inspect protective eyewear for damage,
(d) identify types of eyewear and when the types should or should not be used,
(e) identify the information that manufacturers are responsible to provide, and
(f) identify when broadband eyewear is needed.

Evaluation:

(a) lecture notes
(b) lecture exams
(c) other methods

References:

Mallow and Chabot
Laser Safety Handbook

Unit: Introduction to Lasers (C2)

Objective 1: Development

This objective will introduce the student to the historical development of the laser.

Specifics:

(1) First laser
(2) Historical development
(3) Modern lasers
(4) Future trends

Proficiencies:

Upon completion of this objective the student will be able to:

(a) describe the first operational laser,
(b) trace the development of the laser to modern times, and
(c) suggest possible further uses for laser.

Evaluation:

(a) lecture notes
(b) lecture exams
(c) other methods

References:

Coherent, Inc.
Lasers, operation, equipment, application, and design

Zilczer,
Laser Technology

Unit: Introduction to Lasers (C2)

Objective 2: Properties of Laser Light

This objective will introduce the student to the basic properties of laser light and the difference between coherent and incoherent light.

Specifics:

(1) Incoherent light
(2) Coherent light
(3) Comparison between coherent and incoherent
(4) Power level of incoherent light
(5) Power level of coherent light

Proficiencies:

Upon completion of this objective the student will be able to:

(a) describe incoherent light,
(b) describe coherent light,
(c) calculate power level at various distances from an incoherent source of light,
(d) calculate power level at various distances from a coherent source of light,
(e) use a power meter to measure the power level of the different light sources,
(f) properly mount and aim a low power laser on an optical bench,
(g) properly mount a photodetector on an optical bench,
(h) properly mount a light source on an optical bench, and
(i) properly make power level measurements.

Evaluation:

(a) lecture notes
(b) lecture exams
(c) laboratory notes
(d) laboratory exams
(e) laboratory reports
(f) other methods

References:

Coherent, Inc.
Lasers, operation, equipment, application, and design

Unit: Introduction to Lasers (C2)

Objective 3: The Lasing Process

This objective will introduce the student to the necessary physical properties that must take place before and during the generation of a laser beam.

Specifics:

(1) Fundamental requirements
(2) Population inversion
(3) Lasing sequence
(4) Transverse Beam Modes

Proficiencies:

Upon completion of this objective the student will be able to:

(a) describe the beginning process necessary for lasing to start,
(b) trace stimulated emission from incident photon to generation of stimulated photon,
(c) describe optical pumping,
(d) identify the necessary elements of a laser,
(e) describe each element,
(f) identify the energy levels of a laser system,
(g) describe population inversion,
(h) describe the need for population inversion in a laser system,
(i) describe the events in a laser resonator from the beginning of stimulation until the beam is produced, and
(j) identify the different cross-sectional shapes of a laser beam in transverse electromagnetic (TEM) mode terms.

Evaluation:

(a) lecture notes
(b) lecture exams
(c) other methods

References:

Coherent, Inc.
Lasers, operation, equipment, application, and design

Pike,
Lasers and Masers

Unit: Introduction to Lasers (C2)

Objective 4: Types of Lasers

This objective will introduce the student to the various types of laser systems and their operational characteristics.

Specifics:

(1) Axial-flow lasers
(2) Sealed-tube lasers
(3) Helium-Neon lasers
(4) Gallium-Arsenide lasers
(5) Ruby lasers
(6) Glass lasers
(7) Solid-state lasers
(8) Operational characteristics

Proficiencies:

Upon completion of this objective the student will be able to:

(a) identify the elements of each laser system,
(b) describe the lasing process for each system, and
(c) identify the operational characteristics for each laser system.

Evaluation:

(a) lecture notes
(b) lecture exams
(c) other methods

References:

Brown,
Lasers, tools of modern technology

Pike,
Lasers and Masers

Coherent, Inc.
Lasers, operation, equipment, application, and design

Unit: General Optics I (C3)

Objective 1: Introduction

This objective will introduce the student to the originators of the various theories of light, and the characteristics and sources of light.

Specifics:

(1) Greek's theory
(2) Newton's corpuscular theory
(3) Huygen's theory
(4) Maxwell's theory
(5) Plank's Quantum theory
(6) Compton's experiments
(7) Modern theories of light
(8) Natural and artifical sources of light

Proficiencies:

Upon completion of this objective the student will be able to:

(a) trace the development of theories of light,
(b) describe the characteristics of the various theories of light,
(c) identify natural sources of light, and
(d) identify artifical sources of light.

Evaluation:

(a) lecture notes
(b) lecture exams
(c) other methods

References:

U.S. Navy
Opticalman 3 & 2

Andrews,
Optics of the Electromagnetic Spectrum

Unit: General Optics I (C3)

Objective 2: Light

This objective will enable the student to recognize the characteristics of light, illumination, and radiation.

Specifics:

(1) luminous body
(2) illuminated body
(3) foot-candles
(4) thermal radiation

Proficiencies:

Upon completion of this objective the student will be able to:

(a) recognize a luminous body,
(b) recognize an illuminated body,
(c) describe the difference between an illuminated body and a luminous body,
(d) describe a foot-candle,
(e) calculate foot-candles,
(f) make light intensity measurement with a foot-candle meter,
(g) describe thermal radiation, and
(h) identify methods of measuring thermal radiation.

Evaluation:

(a) lecture notes
(b) lecture exams
(c) laboratory notes
(d) laboratory exams
(e) laboratory reports
(f) other methods

References:

U.S. Navy
Opticalman 3 & 2

Andrews,
Optics of the Electromagnetic Spectrum

Unit: General Optics I (C3)

Objective 3: Light Transmission

In this objective the student will learn to identify the characteristics of light transmission, and its uses.

Specifics:

(1) Transmission of light
(2) Light rays
(3) Wavelength and frequency
(4) Electromagnetic spectrum
(5) Speed of light
(6) Roemer's measurements
(7) Michelson's measurements

Proficiencies:

Upon completion of this objective the student will be able to:

(a) identify mechanisms for the transmission of light,
(b) identify the components of a light ray,
(c) recognize the difference between a cured and parallel wavefront,
(d) define wavelength and frequency,
(e) use the formula $c=f\lambda$
(f) specify wavelength in millimicrons and in Angstrums,
(g) identify the characteristics of the electromagnetic spectrum,
(h) specify wavelength for light from infrared through ultraviolet,
(i) experimentally determine the speed of light,
(j) describe Roemer's experiment for measuring the speed of light, and
(k) describe Michelson's measurements for measuring the speed of light.

Evaluation:

(a) lecture notes
(b) lecture exams
(c) laboratory notes
(d) laboratory exams
(e) laboratory reports
(f) other methods

References:

U.S. Navy
Opticalman 3 & 2

Andrews
Optics of the Electromagnetic Spectrum

Unit: General Optics I (03)

Objective 4: Color

In this objective the student will learn to identify the characteristics of light which determine its variations of color.

Specifics:

(1) Visible colors
(2) dispersion
(3) selective reflection and absorption

Proficiencies:

Upon completion of this objective the student will be able to:

(a) describe the characteristics of sun light,
(b) prove that sun light is made up of many colors,
(c) define dispersion,
(d) use dispersion to explain why a prism will break up sun light into is many colors,
(e) describe selective reflection,
(f) desvribe selective absorption, and
(g) use selective reflection and absorption to explain why objects have color.

Evaluation:

(a) lecture notes
(b) lecture exams
(c) laboratory notes
(d) laboratory exams
(e) laboratory reports
(f) other methods

References:

U.S. Navy
Opticalman 3 & 2

Andrews
Optics of the Electromagnetic Spectrum

Unit: General Optics I (C3)

Objective 5: Affects on light

In this objective the student will learn to determine how light is affected as it passes through various media.

Specifics:

(1) Visibility of objects
(2) opaque
(3) Translucent
(4) Transparent

Proficiencies:

Upon completion of this objective the student will be able to:

(a) specify what light is,
(b) explain how light reacts with matter,
(c) explain visual determination,
(d) explain what makes an object opaque,
(e) explain what makes an object translucent,
(f) explain what makes an object transparent, and
(g) experimentally show the difference between opaque, translucent, and transparent objects.

Evaluation:

(a) lecture notes
(b) lecture exams
(c) laboratory notes
(d) laobratory exams
(e) laobratory reports
(f) other methods

References:

U.S. Navy
Opticalman 3 & 2

Andrews
Optics of the Electromagnetic Spectrum

Unit: General Optics I (C3)

Objective 6: Reflection and refraction

This objective will introduce the student to the laws of reflection and refraction.

Specifics:

(1) Incident wave
(2) Reflected wave
(3) Normal
(4) Angle of incidence
(5) Angle of reflection
(6) Laws of reflection
(7) Regular reflection
(8) Diffuse reflection
(9) Refraction
(10) Incident wave
(11) Refracted wave
(12) Emergent wave
(13) Laws of refraction
(14) Angle of incidence
(15) Normal
(16) Angle of refraction
(17) Angle of deviation
(18) Index of refraction
(19) Snell's law
(20) Law of reversibility

Proficiencies:

Upon completion of this objective the student will be able to:

(a) explain reflection,
(b) define the terms, incident ray, reflected ray, normal, angle of incidence, and angle of reflection,
(c) state the basic statements of the law of reflection,
(d) experimentally prove the law of reflection,
(e) explain refraction,
(f) identify the incident ray, refracted ray, and emergent ray on a refracted light beam,
(g) state the basic statements of the law of reflection,
(h) experimentally prove the law of refraction,
(i) identify the normal, angle of incidence, and angle of refraction on a refracted light beam,
(j) define angle of deviation,
(k) experimentally measure the angle of deviation,
(l) define index of refraction,
(m) calculate index of refraction,
(n) use Snell's law to determine angle of refraction,
(o) experimentally prove Snell's law,
(p) define the law of reversibility,
(q) experimentally prove the law of reversibility, and
(r) trace a reflected and a refracted wave.

Evaluation:

(a) lecture notes
(b) lecture exams
(c) laboratory notes
(d) laboratory exams
(e) laboratory reports
(f) other methods

References:

U.S. Navy
Opticalman 3 & 2

Andrews
Optics of the Electromagnetic Spectrum

Unit: General Optics I (C3)

Objective 7: Problem with refraction

In this objective the student will be introduced to problems involving refraction of light.

Specifics:

(1) Refraction and reflection combined
(2) Total internal reflection
(3) Critical angle
(4) Atmosphere refraction
(5) Mirages
(6) Looming
(7) Heat waves
(8) Rainbows

Proficiencies:

Upon completion of this objective the student will be able to:

(a) explain why refraction and reflection occur at the same time,
(b) define internal reflection,
(c) trace a wave that includes reflection and refraction,
(d) identify problems associated with the combination of reflection and refraction in an optical system,
(e) experimentally show how refraction and reflection effect visibility,
(f) define total internal reflection,
(g) define critical angle,
(h) use Snell's law to calculate critical angle,
(i) explain atmospheric refraction,
(j) explain a mirage,
(k) explain looming,
(l) explain heat waves, and
(m) explain the formation of a rainbow.

Evaluation:

(a) lecture notes
(b) lecture exams
(c) laboratory notes
(d) laboratory exams
(e) laboratory reports
(f) other methods

References:

U.S. Navy
Opticalman 3 & 2

Andrews
Optics of the Electromagnetic Spectrum

Unit: General Optics I (C3)

Objective 8: Measurement Systems

In this objective the student will learn to recognize the basic principles and methods of using metric, English, mil, and degree systems for optical measurements.

Specifics:

(1) Metric system
(2) Metric-English conversion
(3) Degree system
(4) the mil

Proficiencies:

Upon completion of this objective the student will be albe to:

(a) describe the basic units of the metric system,
(b) convert from the English system to the Metric system,
(c) convert from the metric system to the English System,
(d) describe the degree systme of measuring angles,
(e) use the mil as a measurement,
(f) measure distance, weight, and volume with either the English or Metric system,
(g) properly measure angles, and
(h) make measurement using the mil.

Evaluation:

(a) lecture notes
(b) lecture exams
(c) laboratory notes
(d) laboratory exams
(e) laboratory reports
(f) other methods

References:

U.S. Navy
Opticalman 3 & 2

Andrews
Optics of the Electromagnetic Spectrum

Unit: General Optics I (C3)

Objective 9: Images

This objective will point out characteristics of images and the effects prisms and mirrors have on them.

Specifics:

(1) Image description
(2) Real image
(3) Virtual image
(4) Image attitude
(5) Normal and erect
(6) Reverted and erect
(7) Normal and inverted
(8) Reverted and inverted
(9) Image transmission
(10) Plane mirrors
(11) Refracting Prisms
(12) Wedge
(13) Prism diopter
(14) Reflecting prisms
(15) Right angle prisms
(16) Porro prisms
(17) Dove prisms
(18) Rhomboid prisms
(19) Penta prisms
(20) roof-edge prisms
(21) Schmidt prisms
(22) Prism defects

Proficiencies:

Upon completion of this objective the student will be able to:

(a) describe a real image,
(b) describe a virtual image,
(c) describe image attitude,
(d) describe a normal and erect image,
(e) experimentally produce a normal and erect image,
(f) describe a reverted and erect image,
(g) experimentally produce a reverted and erect image,
(h) describe a normal and inverted image,
(i) experimentally produce a normal and inverted image,
(j) describe a reverted and inverted image,
(k) experimentally produce a reverted and inverted image,
(l) describe the methods of image transmission,
(m) describe the use of plane mirrors,
(n) experimentally show the operation of plane mirrors,
(o) describe the refracting prism,
(p) describe the wedge,
(q) experimentally show the operation of the wedge,
(r) explain prism diopter,
(s) calculate prism diopter,

(t) describe reflecting prisms,
(u) describe the right-angle prism,
(v) experimentally show the operation of a right-angle prism,
(w) describe the porro prism,
(x) experimentally show the operation of a porro prism,
(y) describe the dove prism,
(z) experimentally show the operation of a dove prism,
(aa) describe the rhombord prism,
(bb) experimentally show the operation of a rhombord prism,
(cc) describe the penta prism,
(dd) experimentally show the operation of a penta prism,
(ee) define constant deviation,
(ff) describe the roof-edge prism,
(gg) experimentally show the operation of a roof-edge prism,
(hh) describe the Schmidt prism,
(ii) experimentally show the operation of an Schmidt prism,
(jj) preform ray tracing through each type of prism,
(kk) describe the type of image produced by each prism, and
(ll) identify prism defects.

Evaluation:

(a) lecture notes
(b) lecture exams
(c) laboratory notes
(d) laboratory exams
(e) laboratory reports
(f) other methods

Reference:

U.S. Navy
Opticalman 3 & 2

Unit: General Optics I (C3)

Objective 10: Properties of Glass

This objective will point out the properties of glass, and optical qualities similar for other materials transparent in the infrared.

Specifics:

(1) Physical properties of glass
(2) Optical qualities
(3) Homogeneity
(4) Transparency
(5) Freedom from color
(6) Refraction
(7) Dispertion
(8) Types of glass
(9) Types of lenses
(10) Thin lenses
(11) Thick lenses
(12) Compound lenses
(13) Converging lenses
(14) Diverging lenses

Proficiencies:

Upon completion of this objective the student will be able to:

(a) describe the property of glass,
(b) describe the physical properties of glass,
(c) explain why glass is a liquid,
(d) identify the properties of optical quality,
(e) describe homogeneity,
(f) test for homogeneity,
(g) describe transparency,
(h) test for transparency,
(i) describe freedom from color,
(j) test for freedom from color,
(k) describe refraction,
(l) test for refraction,
(m) describe dispertion,
(n) test for dispertion,
(o) identify types of optical glass,
(p) identify characteristics of each type of glass,
(q) describe the categories of lenses,
(r) describe thin lenses,
(s) describe thick lenses,
(t) describe compound lenses,
(u) identify different types of converging lenses,
(v) identify different types of diverging lenses,
(w) experimentally show the characteristics of converging lenses,
(x) experimentally show the characteristics of diverging lesnse, and
(y) clean each type of lens without damage to surface finishes.

Evaluation:

(a) lecture notes
(b) lecture exams
(c) laboratory notes
(d) laboratory exams
(e) laboratory reports
(f) other methods

References:

U.S. Navy
Opticalman 3 & 2

Unit: General Optics II (C4)
Objective 1: Lems Terminology

In this objective the student will learn lens terminology by defining terms used in the study of lenses.

Specifics:

(1) Curvature
(2) Radius of curvature
(3) Focal length
(4) Optical axis
(5) Principal plane
(6) Optical center
(7) Principal focus
(8) Principal focal plane

Proficiencies:

Upon completion of this objective the student will be able to:

(a) describe the curvatur of a lens as it relates to the surface of a sphere,
(b) define radius of curvature,
(c) devine focal length,
(d) identify the optical axis,
(e) relate focal length to optical axis,
(f) identify the prinicpal plane,
(g) identify optical center,
(h) identify principal focus,
(i) identify prinicpal focal plane,
(j) plot focal lengths of a convergent lens,
(k) plot focal length of a divergent lens, and
(l) identify lens terminology on a lens diagram.

Evaluation:

(a) lecture notes
(b) lecture exams
(c) other methods

Reference:

U.S. Navy
Opticalman 3&2

Unit: General Optics II (C4)
Objective 2: Positive and Negative lenses

In this objective the student will learn to identify the characteristics of positive and negative lenses.

Specifics:

(1) Converging lenses
(2) Diverging lenses

Proficiencies:

Upon completion of this objective the student will be able to:

(a) describe positive lenses
(b) describe negative lenses, and
(c) show how each type of lens is constructed from prisms varying in number, size, and shape.

Evaluation:

(a) lecture notes
(b) lecture exams
(c) other methods

Reference:

U.S. Navy
Opticalman 3&2

Unit: General Optics II (C4)
Objective 3: Image Formation

In this objective the student will learn to recognize the elements of image formation.

Specifics:

(1) Image formation
(2) Principal light rays
(3) Image formation with positive lenses
(4) Image formation with negative lenses

Proficiencies:

Upon completion of this objective the student will be able to:

(a) describe how the laws of refraction apply to image formation,
(b) identify principal light rays,
(c) perform ray tracing through a positive lens, and
(d) perform ray tracing through a negative lens.

Evaluation:

(a) lecture notes
(b) lecture exams
(c) other methods

Reference:

U.S. Navy
Opticalman 3&2

Unit: General Optics II (C4)
Objective 4: Lenses and Mirrors

In this objective the student will learn to recognize the purpose and use of cylindrical lenses and spherical mirrors.

Specifics:

(1) Positive cylindrical lenses
(2) Negative cylindrical lenses
(3) Spherical mirrors
(4) Concave spherical mirrors
(5) Parabolic reflectors
(6) Convex mirror

Proficiencies:

Upon completion of this objective the student will be able to:

(a) describe postitive and negative cylindrical lenses,
(b) give uses for positive or negative cylindrical lenses,
(c) explain spherical mirrors,
(d) describe concave spherical mirrors,
(e) show construction of a concave mirror,
(f) shop position of image formed by a concave mirror,
(g) show convergence of light rays produced by a point source of light,
(h) describe parabolic reflectors,
(i) show light rays produced by a parabolic reflector from a point source of light,
(j) describe a convex mirror, and
(k) show image formation by a convex mirror.

Evaluation:

(a) lecture notes
(b) lecture exams
(c) other methods

Reference:

U.S. Navy
Opticalman 3&2

Unit: General Optics II (C4)
Objective 5: Lens Formulas

In this objective the student will learn to solve problems related to lens formulas.

Specifics:

(1) Focal length
(2) Image position
(3) Magnification
(4) Magnifying power

Proficiencies:

Upon completion of this objective the student will be able to:

(a) calculate focal length,
(b) use the formula: $\frac{1}{F} = \frac{1}{D_o} + \frac{1}{D_i}$ for focal length,
(c) calculate image position,
(d) use the formula: $\frac{1}{F} = \frac{1}{D_o} + \frac{1}{D_i}$ for image position,
(e) describe magnification,
(f) calculate magnification,
(g) use the formula: $M = \frac{D_i}{D_o}$
(h) desribe magnifying power, and
(i) calculate magnifying power.

Evaluation:

(a) lecture notes
(b) lecture exams
(c) other methods

Reference:

U.S. Navy
Opticalman 3&2

Unit: General Optics II (C4)
Objective 6: Lens Diopter

In this objective the student will learn to identify the principles of the lens diopter and calculate dioptric strength, and relative aperture.

Specifics:

(1) Lens diopter
(2) Dioptric strength
(3) Relative aperture
(4) Relative image brightness

Proficiencies:

Upon completion of this objective the student will be able to:

(a) define lens diopter,
(b) describe refractive power,
(c) define dioptric strength,
(d) calculate dioptric strength for positive and negative lenses,
(e) desribe relative aperture,
(f) calculate relative aperture,
(g) show how a brighter image is formed by short focal length lenses, and
(h) show how a brighter image is formed by enlarging the lens aperture.

Evaluation:

(a) lecture notes
(b) lecture exams
(c) laboratory notes
(d) laboratory exams
(e) laboratory reports
(f) other methods

Reference:

U.S. Navy
Opticalman 3&2

Unit: General Optics II (C4)
Objective 7: Lens Aberrations

In this objective the student will learn to identify the problems associated with lens aberrations, and the methods used to correct them.

Specifics:

(1) Chromatic
(2) Spherical
(3) Coma
(4) Astigmatism
(5) Curvature of the field
(6) Distortion
(7) Newton's rings

Proficiencies:

Upon completion of this objective the student will be able to:

(a) identify chromatic aberration,
(b) describe how chromatic aberration occurs,
(c) show how to correct chromatic aberration,
(d) identify spherical aberration in a converging and a diverging lens,
(e) desribe how spherical aberration occurs,
(f) show how spherical aberration can be reduced by a field lens,
(g) show how spherical aberration can be eliminated by a compound lens,
(h) identify coma aberration,
(i) describe how coma occurs,
(j) describe methods for reducing coma,
(k) desribe an aplantic lens,
(l) identify astigmatism,
(m) identify circle of least confusion,
(n) desribe methods used to reduce astigmatism,
(o) identify curvatur of field,
(p) desribe how curvature of field occurs,
(q) desribe how to reduce curvature of field,
(r) identify barrel distortion,
(s) identify pin cushion distortion,
(t) desribe methods used to reduce barrel and pin cushion distortion,
(u) desribe Newton's rings, and
(v) identify diffraction patterms.

Evaluation:

(a) lecture notes
(b) lecture exams
(c) laboratory notes
(d) laboratory exams
(e) laboratory reports
(f) other methods

Reference:

U.S. Navy
Opticalman 3&2

Unit: General Optics II (C4)
Objective 8: Thick lenses

In this objective the student will learn to trace the path of light through a thick lens and identify the factors particular to thick lenses.

Specifics:

(1) Thick lenses
(2) Front focal length
(3) Equivalent focal length
(4) Back focal length
(5) Compound lenses
(6) Lens combinations

Proficiencies:

Upon completion of this objective the student will be able to:

(a) desribe a thick lens,
(b) compare ray paths through thin and thick lenses,
(c) identify the from focal length,
(d) identify the equivalent focal length,
(e) identify the back focal length,
(f) desribe a compound lens,
(g) identify a doublet, dialyte and triplet compound lens,
(h) show how symmetrical thin lenses are used in combination to form a thick lens, and
(i) trace light rays through the thick and compound lens.

Evaluation:

(a) lecture notes
(b) lecture exams
(c) laboratory notes
(d) laboratory exams
(e) laboratory reports
(f) other methods

Reference:

U.S. Navy
Opticalman 3&2

Unit: General Optics II (C4)
Objective 9: Miscellaneous Optical Elements

In this objective the student will learn to recognize the uses of recticles, color filters, and polaroid filters.

Specifics:

(1) Recticles
(2) Color filters
(3) Polaroid filters

Proficiencies:

Upon completion of this objective the student will be able to:

(a) desribe a recticle,
(b) identify uses for a recticle,
(c) desribe color filters,
(d) identify uses for color filters,
(e) desribe polaroid filters, and
(f) identify uses for polaroid filters.

Evaluation:

(a) lecture notes
(b) lecture exams
(c) laboratory notes
(d) laboratory exams
(e) laboratory reports
(f) other methods

Reference:

U.S. Navy
Opticalman 3&2

Unit: General Optics II (C4)
Objective 10: Eyepieces

In this objective the student will learn to identify the type amd makeup of eyepieces.

Specifics:

(1) Huygens
(2) Ramsden
(3) Kellner
(4) Symmetrical and two doublet
(5) Orthoscopic
(6) Internal focusing

Proficiencies:

Upon completion of this objective the student will be able to:

(a) desribe the basic function of an eyepiece,
(b) trace light rays through a basic eyepiece,
(c) desribe a Huygens eyepiece,
(d) trace light rays through a Huygenian eyepiece,
(e) desribe a Ramsden eyepiece,
(f) trace light rays through a Ramsden eyepiece,
(g) desribe a Kellner eyepiece,
(h) trace light rays through a Kellner eyepiece,
(i) desribe a symmetrical eyepiece,
(j) trace light rays through a symmetrical eyepiece,
(k) desribe an orthoscopic eyepiece,
(l) trace light rays through an orthoscopic eyepiece,
(m) describe an internal focusing eyepiece, and
(n) trace light rays through an internal focusing eyepiece.

Evaluation:

(a) lecture notes
(b) lecture exams
(c) laboratory notes
(d) laboratory exams
(e) laboratory reports
(f) other methods

Reference:

U.S. Navy
Opticalman 3&2

Unit: General Optics II (C4)
Objective 11: Telescopes

In this objective the student will learn to recognize the makeup and construction of the simple telescope.

Specifics:

(1) Astronomical telescopes
(2) Terrestrial telescopes
(3) Telescope magnification
(4) The microscope

Proficiencies:

Upon completion of this objective the student will be able to:

(a) describe a telescope,
(b) describe an astronomical telescope,
(c) desribe a Newtonian reflecting telescope,
(d) desribe a Cassegranian reflecting telescope,
(e) desribe a refracting telescope,
(f) trace light rays through, and identify and desribe free aperture, exit pupil, eye distance, true field, and apparent field in a refracting telescope,
(g) desribe a terrestrial telescope,
(h) describe a Galilean telescope,
(i) trace light rays through a Galilean telescope,
(j) describe a basic erector telescope,
(k) trace light rays through a one erector telescope,
(l) trace light through a two erector telescope,
(m) identify conjugate points,
(n) describe variable power in a telescope,
(o) desribe a porro prism erecting system,
(p) trace light rays through a porro prism erecting system,
(q) describe parallex,
(r) desribe how to correct parallex,
(s) determine the power of a telescope, and
(t) desribe image creation by a compound microscope.

Evaluation:

(a) lecture notes
(b) lecture exams
(c) laboratory notes
(d) laboratory exams
(e) laboratory reports
(f) other methods

Reference:

U.S. Navy
Opticalman 3 & 2

Unit: Laser Optics (C5)

Objective 1: Optical Benches

This objective will introduce the student to the uses of an optical bench.

Specifics:

(1) Description
(2) Mounting
(3) Alignment
(4) Problems

Proficiencies:

Upon completion of this objective the student will be able to:

(a) properly mount an optical bench on an optical table,
(b) properly align the optical bench,
(c) describe procedures for keeping misalignments to a minimum, and
(d) describe procedures to keep vibrations to a minimum.

Evaluation:

(a) lecture notes
(b) lecture exams
(c) laboratory notes
(d) laboratory exams
(e) laboratory reports
(f) other methods

Reference:

Manufactures operational manual for specific bench purchased.

Manufacturers maintenance manual

Unit: Laser Optics (C5)

Objective 2: Component Supports

This objective will introduce the student to the various types of component supports, the proper method of mounting optical and electro-optical components on these supports, and the mounting of the component supports on an optical bench.

Specifics:

(1) Supports
(2) Component mounting
(3) Component alignment
(4) Mounting on optical bench
(5) Alignment on optical bench

Proficiencies:

Upon completion of this objective the student will be able to:

(a) determine the type of mount needed for different types of components,
(b) mount the component within the support without distortion of either the mount or component,
(c) square the alignment of the component within the mount,
(d) properly place the component mount on an optical bench, and
(e) properly align the component support on the optical bench.

Evaluation:

(a) lecture notes
(b) lecture exams
(c) laboratory notes
(d) laboratory exams
(e) laboratory reports
(f) other methods

Reference:

Manufacturers operational manual

Manufacturers maintenance manual

Unit: Laser Optics (C5)

Objective 3: Photo Detectors

This objective will introduce the student to the various methods of photo detection.

Specifics:

(1) The photon
(2) The photovoltaic cell
(3) Photomultiplier
(4) Photo Detectors

Proficiencies:

Upon completion of this objective the student will be able to:

(a) identify the properties of a photon,
(b) describe the operation of a photovoltaic cell,
(c) describe the operation of a photomultiplier tube, and
(d) use a photovoltaic cell and photomultiplier tube as a detector.

Evaluation:

(a) lecture notes
(b) lecture exams
(c) laboratory notes
(d) laboratory exams
(e) laboratory reports
(f) other methods

References:

Kloeffler, Horrell, and Hargrave
Basic Electronics

RCA
RCA Tube Manual

Unit: Laser Optics (C5)

Objective 4: Power Meters

This objective will introduce the student to the instruments used to measure laser power.

Specifics:

(1) Calorimeters
(2) Power meters

Proficiencies:

Upon completion of this objective the student will be able to:

(a) explain teh operation of a calorimeter,
(b) properly mount and align a calorimeter on a component support and on an optical bench,
(c) use a calorimeter to measure laser power,
(d) explain the operation of a laser power meter,
(e) properly mount and align a power meter on a component support and on an optical bench, and
(f) use a power meter to measure laser power.

Evaluation:

(a) lecture notes
(b) lecture exams
(c) laboratory notes
(d) laboratory exams
(e) laboratory reports
(f) other methods

References:

Manufacturers operational manual

Manufacturers maintenance manual

Unit: Laser Optics (C5)

Objective 5: Rotating Prism

In this objective the student will learn about the operation, mounting nad alignment of a rotating prism.

Specifics:

(1) Operational characteristics
(2) Rotational speed
(3) Mounting on a component support
(4) Mounting on an optical bench
(5) Alignment procedures

Proficiencies:

Upon completion of this objective the student will be able to:

(a) describe the operational characteristics,
(b) adjust rotational speed,
(c) syncronize rotation with laser pulses,
(d) properly mount a rotating mirror, and
(e) properly align a rotating mirror.

Evaluation:

(a) lecture notes
(b) lecture exams
(c) laboratory notes
(d) laboratory exams
(e) laboratory reports
(f) other methods

References:

Manufacturers operational manual

Manufacturers maintenance manual

Unit: Laser Optics (C5)

Objective 6: Rotating Mirrors

In this objective the student will learn about the operation, mounting, and alignment of a rotating mirror.

Specifics:

(1) Operational characters
(2) Rotational speed
(3) Mounting on a component support
(4) Mounting on an optical bench
(5) Alignment procedures

Proficiencies:

Upon completion of this objective the student will be able to:

(a) describe the operational characteristics,
(b) adjust rotational speed,
(c) syncronize rotational speed with laser output,
(d) properly mount a rotating mirror, and
(e) properly align a rotating mirror.

Evaluation:

(a) lecture notes
(b) lecture exams
(c) laboratory notes
(d) laboratory exams
(e) laboratory reports
(f) other methods

Reference:

Manufacturers operational manual

Manufacturers maintenance manual

Unit: Laser Optics (C5)

Objective 7: Optical Windows

In this objective the student will learn about the operation, mounting, and alignment of an optical window.

Specifics:

(1) Operational characteristics
(2) Uses
(3) Mounting on a component support
(4) Mounting on an optical bench
(5) Alignment procedures

Proficiencies:

Upon completion of this objective the student will be able to:

(a) describe the operational characteristics,
(b) give examples of uses,
(c) properly mount an optical window, and
(d) properly align an optical window

Evaluation:

(a) lecture notes
(b) lecture exams
(c) laboratory notes
(d) laboratory exams
(e) laboratory reports
(f) other methods

References:

Manufacturers operational manual

Manufacturers maintenance manual

Unit: Laser Optics (C5)

Objective 8: Beamsplitters

In this objective the student will learn about the operation, mounting, and alignment of a beamsplitter.

Specifics:

(1) Types
(2) Operational characteristics
(3) Uses
(4) Mounting on a component support
(5) Mounting on an optical bench
(6) Alignment procedures

Proficiencies:

Upon completion of this objective the student will be able to:

(a) identify types of beamsplitters,
(b) describe the operational characteristics of beamsplitters,
(c) give examples of uses for beamsplitters,
(d) properly mount a beamsplitter, and
(e) properly align a beamsplitter.

Evaluation:

(a) lecture notes
(b) lecture exams
(c) laboratory notes
(d) laboratory exams
(e) laboratory reports
(f) other methods

References:

Manufacturers operational manual

Manufacturers maintenance manual

Unit: Laser Optics (C5)

Objective 9: Etalons

In this objective the student will learn about the operation, mounting, and alignment of an etalon.

Specifics:

(1) Types
(2) Operational characteristics
(3) Uses
(4) Mounting on component supports
(5) Mounting on an optical bench
(6) Alignment procedures

Proficiencies:

Upon completion of this objective the student will be able to:

(a) identify types of etalons,
(b) describe the operational characteristics of etalons,
(c) give example of etalon uses,
(d) properly mount an etalon, and
(e) properly align an etalon.

Evaluation:

(a) lecture notes
(b) lecture exams
(c) laboratory notes
(d) laboratory exams
(e) laboratory reports
(f) other methods

References:

Manufacturers operational manual

Manufacturers maintenance manual

Unit: Laser Optics (C5)

Objective 10: Fiber Optics

This objective will introduce the student to the operation and characteristics of fiber optics.

Specifics:

(1) Types of fibers
(2) Light transmission through a fiber
(3) Transmitting units
(4) Receiving units

Proficiencies:

Upon completion of this objective the student will be able to:

(a) describe crown glass fibers,
(b) describe flint glass fibers,
(c) describe other types of fibers,
(d) compare the characteristics of each type of fiber,
(e) explain how light is transmitted through the different types of fibers,
(f) describe the operation of fiber optic transmitters,
(g) describe the operation of fiber optic receivers,
(h) mount, align, and operate a fiber optic transmitter, and
(i) mount, align, and operate a fiber optic receiver.

Evaluation:

(a) lecture notes
(b) lecture exams
(c) laboratory notes
(d) laboratory exams
(e) laboratory reports
(f) other methods

Reference:

Barnowski,
Fundamentals of Optical Fiber Communication

Unit: Laser Operation (C6)

Objective 1: Power Up Sequency

This objective will teach the student the safe and proper method of taking a high power from a cold start to maximum output.

Specifics:

(1) Laser log
(2) Cooling system
(3) Start up procedure

Proficiencies:

Upon completion of this objective the student will be able to:

(a) follow proper lab check out,
(b) maintain proper paper work,
(c) examine the laser system for damage,
(d) run the cooling system, and
(e) properly start the lasing elements.

Evaluation:

(a) lecture exam
(b) laboratory exam

Suggestive chechout sheet for different types of lasers follows objective 2.

References:

Laser manufacturers operational manual

Unit: Laser Operation (C6)

Objective 2: Power Down Sequence

This objective will teach the student the safe and proper method of taking a high power laser from maximum output to a cold stop.

Specifics:

(1) Laser log
(2) Power down procedure
(3) Cooling system

Proficiencies:

Upon completion of this objective the student will be able to:

(a) properly stop the lasing elements,
(b) stop the cooling system,
(c) examine the laser system for damage,
(d) maintain proper paper work, and
(e) follow proper lab check out.

Evaluation:

(a) lecture exam
(b) laboratory exam

Suggestive chech out sheet for different types of lasers follows this objective.

References:

Laser manufacturers operational manual

Unit: Laser Measurements (C7)

Objective 1: Laser Parameters and Measurements

This objective will introduce the student to the basic laser parameters, handling of data, and reference symbols used.

Specifics:

(1) Principal laser parameters
(2) Treatment of data
(3) Symbols

Proficiencies:

Upon completion of this objective the student will be able to:

(a) identify external beam parameters
(b) identify internal beam parameters
(c) explain the need for precision and accuracy in beam measurement,
(d) identify types of errors,
(e) explain Gauss Distribution, and
(f) identify those principal symbols used in the measurement of laser beams.

Evaluation:

(a) lecture notes
(b) lecture exams
(c) laboratory notes
(d) laboratory reports
(e) other methods

Reference:

heard,
Laser Parameter Measurements Handbook

Unit: Laser Measurement (C7)

Objective 2: Beam-Sampling Techniques

This objective will introduce the student to those techniques used to ensure that a quantitative, representative sample of a beam is obtained.

Specifics:

(1) Amplitude division
(2) Beam Scattering
(3) Induced florescence
(4) Harmonic conversion
(5) Photo decomposition
(6) Resonant transition monitoring
(7) Sources of error

Proficiencies:

Upon completion of this objective the student will be able to:

(a) explain the use of a Fresnel reflector as a beam splitter,
(b) explain thin-film and Grating techniques,
(c) explain beam scattering,
(d) explain the use of induced florenscences for monitoring various types of laser beams,
(f) explain harmonic conversion,
(g) explain photo decomposition,
(h) explain resonant transition monitoring,
(i) set up and use the various types of beam splitters, and
(j) identify possible sources of error.

Evaluation:

(a) lecture notes
(b) lecture exams
(c) laboratory notes
(d) laboratory exams
(e) laboratory reports
(f) other methods

Reference:

Heard,
Laser Parameter Measurement Handbook

Unit: Laser Measurements (C7)

Objective 3: Measurement of Beam Parameters

This objective will introduce the student to these methods used in the measurement of laser beam parameters.

Specifics:

(1) Instrumentation
(2) Tranverse Intensity Distribution
(3) Beam Divergence
(4) Modes
(5) Polarization
(6) Beam-Spot size
(7) Atmospheric dispertion

Proficiencies:

Upon completion of this objective the student will be able to:

(a) explain the use of a Plane Parallel Fabry-Perot (PPFP) with square aperture,
(b) explain a PPFP with circular aperture,
(c) explain spherical resonators,
(d) explain resonators,
(e) explain fiber optic resonators,
(f) explain ring patterns,
(g) describe the various methods used to measure beam intensity distribution by photography,
(h) describe the various methods used to measure beam intensity distribution by scanning optical dectector,
(i) determine beam divergence,
(j) measure beam divergence,
(k) identify beam modes,
(l) use a spectrograph to identify mode,
(m) identify optical beats,
(n) identify unpolarized light, Plane-polarized light, circularly polarized light, elliptically polarized light, and any combination of the above,
(o) use a polariscope,
(p) measure beam-spot size, and
(q) explain atmospheric dispertion.

Evaluation:

(a) lecture notes
(b) lecture exams
(c) laboratory notes
(d) laboratory exams
(e) laboratory reports
(f) other methods

Reference:

Heard,
Laser Parameter Measurements Handbook

Unit: Laser Measurements (C7)

Objective 4: Measurement of Energy and Power

This objective will introduce the student to the various techniques and instruments used in the measurement of laser energy and power.

Specifics:

(1) Radiometry
(2) Definitions and Units
(3) Calorimetric Methods
(4) Photoelectric Methods
(5) Photochemical Methods
(6) Mechanical Methods
(7) Standards and Calibration
(8) Attenuators
(9) Optical Petection

Proficiencies:

Upon completion of this objective the student will be able to:

(a) explain radiometry,
(b) define radiant energy,
(c) calculate radiant energy,
(d) define radiant power,
(e) calculate radiant power,
(f) explain radiance and spectral radiance,
(g) explain irradiance and spectral irradiance,
(h) explain emissivity and spectral emissivity,
(i) explain the relationship of radiometric to photometric quantities,
(j) explain the general principles of Calorimetric methods methods of measuring energy and power,
(k) explain temperature sensing,
(l) explain volume sensing,
(m) explain pressure sensing,
(n) explain the Golary Cell,
(o) set up and use a calorimeter,
(p) explain the general principles of Photoelectric methods of measuring energy and power,
(q) explain photoemission devices,
(r) explain photoconductive devices,
(s) explain photovoltaic devices,
(t) explain photoionization in gases,
(u) explain fluorescence detectors,
(v) set up and use appropriate photometers,
(w) explain the general principles of photochemical methods of measuring energy and power,
(x) explain photographic methods,
(y) explain actinometric methods,
(z) set up and use appropriate photometers,
(aa) explain the general principles of Mechanical methods of measuring energy and power,
(bb) explain radiant pressure devices,
(cc) explain black-body radiation,

(dd) identify Stefan-Boltzmann Law,
(ee) explain the basic principles of attenuators,
(ff) identify the various types of attenuators,
(gg) define responsivity,
(hh) calculate responsivity,
(ii) explain the use of the various types of optical detectors,
(jj) define noise-equivalent input,
(kk) identify the various techniques for measuring peak power and energy output,
(ll) properly calibrate measuring devices, and
(mm) follow all radiometric standards.

Evaluation:

(a) lecture notes
(b) lecture exams
(c) laboratory notes
(d) laboratory exams
(e) laboratory reports
(f) other methods

Reference:

Heard,
Laser Parameter Measurements Handbook

Unit: Laser Measurements (C7)

Objective 5: Measurement of Wavelength

This objective will introduce the student to the methods and instruments used in the measurement of laser beam wavelength.

Specifics:

(1) Basic Provissions
(2) Line broadening and light sources
(3) Optical-wavelength-measuring apparatus
(4) Wavelength standards
(5) Measurement and reduction of data from spectrographs

Proficiencies:

Upon completion of this objective the student will be able to:

(a) identify problems associated with optical wavelength measurements,
(b) explain line broadening,
(c) identify and explain the causes for line broadening,
(d) explain the types and operation of monochromatic light sources,
(e) set up and operate a monochromatic light source,
(f) identify laser-spectroscopy requirements,
(g) identify instrument parameters,
(h) set up and use a prism spectrograph,
(i) identify prism spectrograph parameters,
(j) identify the parameters in a plane grating,
(k) set up and use grating monochromators,
(l) identify the ray diagram on a Fabry-Perot interferometer,
(m) set up and use a Fabry-Perot interferometer,
(n) identify the wavelength standards for the various types of instruments used, and
(o) apply the correction techniques when interpreting wavelength data.

Evaluation:

(a) lecture notes
(b) lecture exams
(c) laboratory notes
(d) laboratory exams
(e) laboratory reports
(f) other methods

Reference:

Heard,
Laser Parameter Measurements Handbook

Unit: Laser Measurements (C7)

Objective 6: Measurement of Frequency Stability

In this objective the student will be introduced to the terms, methods, and instruments used in measuring the frequency stability of a laser beam.

Specifics:

(1) Definitions of Stability
(2) The frequency stability of lasers and its magnitude
(3) Measurement of short-term stability
(4) Measurement of long-term stability
(5) Laser absolute wavelength stability measurement.

Proficiencies:

Upon completion of this objective the student will be able to:

(a) define stability,
(b) define short-term frequency stability,
(c) define logn-term frequency stability,
(d) define frequency resettability,
(e) define wavelength stability and resettability,
(f) define absolute and relative stability,
(g) identify the short-term frequency stability effects on a laser beam,
(h) identify the long-term frequency stability effects on a laser beam,
(i) identify how resettability effects a laser beam,
(j) explain the optical methods for measureing short-term stability,
(k) set up and use prism and grating spectrometers for measuring short-term stability,
(l) set up and use an interferometer for measuring short-term stability,
(m) explain photoelectric-mixing methods, homodyne detection, heterodyne detection, Quasi heterodyne detection for measuring short-term stability,
(n) explain the optical methods for measuring long-term stability,
(o) set up and use prism and grating spectrometers for measuring long-term stability,
(p) set up and use a Michelson spectrometer for measuring long-term stability,
(q) explain the photoelectric methods for measuring long-term stability,
(r) identify the apparatus and arrangement of a wavelength-comparison spectrometer,
(s) explain the operation of a wavelength-comparison spectrometer, and
(t) identify sources of error in wavelength measurements.

Evaluation:

(a) lecture notes
(b) lecture exams

(c) laboratory notes
(d) laboratory exams
(e) laboratory reports
(f) other methods

Reference:

Heard,
Laser Parameter Measurements Handbook

Unit: Laser Applications (C8)

Objective 1: Optical Storage

This objective will introduce the student to the methods of direct optical storage.

Specifics:

(1) Phase Recording
(2) Amplitude recording
(3) Evaporated thin films

Proficiencies:

Upon completion of this objective the student will be able to:

(a) explain data storage by each of the recording techniques,
(b) explain phase recording by the use of Manganese Bismuth Films,
(c) explain electro-optic phase recording,
(d) explain amplitude recording by the use of inorganic photochromics,
(e) explain amplitude recording by the use of organic photochromics,
(f) explain photochromism by Cis-Trans Isomerization,
(g) explain photochromism by Heterolytic Cleavage,
(h) explain photochromism by Homolytic Clearage,
(i) explain photochromism by Tautomeric Processes,
(j) explain photochromism by Triplet-State Formation, and
(k) explain data storage by evaporated thin films.

Evaluation:

(a) lecture notes
(b) lecture exams

Reference:

Pressley,
Handbook of Lasers

Amodei,
Direct Optical Storage Media, in Pressley, Handbook of Lasers.

Unit: Laser Applications (C8)

Objective 2: Optical Communications System

This objective will introduce the student to the basic parts and procedures of an optical communications system.

Specifics:

(1) The System
(2) Optical transmitters
(3) Modulation techniques
(4) Receiving Techniques
(5) Receiving devices

Proficiencies:

Upon completion of this objective the student will be able to:

(a) explain the operation of an optical communications system,
(b) identify the parts of an optical transmitter,
(c) explain the operation of an optical transmitter,
(d) explain basic modulation techniques,
(e) explain electro-optic modulation,
(f) explain acousto-optic modulation,
(g) explain the piezoelectric modulator,
(h) explain the operation of semiconductor modulators,
(i) explain frequency modulation by electro-optics,
(j) explain basic receiving techniques,
(k) explain photodetection,
(l) explain photomixing,
(m) identify photomixing parameters,
(n) make comparisons between photomixing and photodetection,
(o) explain the operation of photoemissive-type detector, photoconductive-type detector, photovoltaic-type detector, photoelectromagnetic-type detector, quantum amplifier, and photoparametric solid-state detector, and
(p) set up and operate an optical communications system using controled and non-controled channels.

Evaluation:

(a) lecture notes
(b) lecture exams
(c) laboratory notes
(d) laboratory exams
(e) laboratory reports
(f) other methods

References:

Ross, Laser Receivers

Gagliardi and Karp, Optical Communications

Kallard, Acoustic Surface wave and Acousto-Optic Devices

Unit: Laser Applications (C8)

Objective 4: Medicine and Biology

This objective will introduce the student to the ways that laser are used in medicine and the biological sciences.

Specifics:

(1) Retinal Coagulation
(2) Skin cosmetic repair
(3) Skin cancer
(4) Bloodless surgery
(5) Transillumination
(6) Neurosurgery
(7) Dentistry
(8) Laser microscope
(9) Pathology
(10) Molecular studies
(11) Cytology

Proficiencies:

Upon completion of this objective the student will be able to:

(a) describe the operation of lasers in each of the following areas: retinal coagulation, skin cosmetic repair, skin cancer, bloodless surgery, transillumination, neurosurgery, dentistry, pathology, molecular studies, and cytology, and,
(b) describe the operation of a laser microscope.

Evaluation:

(a) lecture notes
(b) lecture exams
(d) other methods

Reference:

Zilczer,
Laser Technology

Unit: Laser Applications (C8)

Objective 3: Meteorology

This objective will introduce the student to the way that Lasers are used in meteorology.

Specifics:

(1) Range finding and altimetry
(2) Laser doppler flowmeter
(3) Laser Absolute Gravimeter
(4) Gas temperature measurement
(5) Pollutant detection
(6) Plasma diagnostics
(7) Electro-Optical plumb line
(8) Measurement of optical thickness
(9) Point coordinate locator
(10) Ring lasers

Proficiencies:

Upon completion of this objective the student will be able to:

(a) describe the operation of an optical range finder and receiver,
(b) operate an optical range finder,
(c) describe the operation of an optical system for fluid velocity measurements,
(d) operate a laser doppler flowmeter,
(e) describe the operation of a laser gravimeter,
(f) operate a laser gravimeter,
(g) describe the operation of a Raman spectrophotometer for gas temperature measurement,
(h) operate a Raman spectrophotometer,
(i) describe the detection of atmospheric pollutants by absorption, thermal emmission, and flourescence,
(j) operate a laser atmospheric pollutant detector,
(k) describe the use of lasers in plasma diagnosis,
(l) describe the operation of a true vertical laser,
(m) operate an electro-optical plumb line,
(n) describe the procedure for measuring optical thickness,
(o) make optical thickness measurements,
(p) describe a point coordinate locator,
(q) describe a ring laser.

Evaluation:

(a) lecture notes
(b) lecture exams
(c) laboratory notes
(d) laboratory exams
(e) laboratory reports
(f) other methods

Reference:

Zilczer, Laser Technology

Unit: Laser Applications (C8)

Objective 5: Industry

This objective will introduce the student to the ways that lasers are used in industry.

Specifics:

(1) Metallurgy
(2) Welding
(3) Drilling
(4) Machining
(5) Photographic platemaking
(6) Machine tool industry
(7) Garment industry

Proficiencies:

Upon completion of this objective the student will be able to:

(a) explain the operation of lasers in metallurgy,
(b) describe welding with a laser,
(c) describe how lasers can be used in drilling extremely hard substances,
(d) describe how lasers can be used in balancing operations,
(e) describe photographic platemaking, and
(f) describe the use of lasers in the machine tool and garment industries.

Evaluation:

(a) lecture notes
(b) lecture exams
(c) other methods

Reference:

Zilczer,
Laser Technology

Unit: Laser Applications (C8)

Objective 6: Holography

In this objective the student will learn the methods and techniques of making holographic plates.

Specifics:

(1) Holographs
(2) System set up
(3) Alignment
(4) Plate exposure
(5) Plate development

Proficiencies:

Upon completion of this objective the student will be able to:

(a) describe the different methods of producing holographs,
(b) set up and align a laser in a holographic system,
(c) properly expose a holographic plate, and
(d) properly develop a holographic plate.

Evaluation:

(a) lecture notes
(b) lecture exams
(c) laboratory notes
(d) laboratory exams
(e) laboratory reports
(f) other methods

Reference:

Dudley,
Holography

Objective 4

Teaching and Evaluation Strategies

The basic teaching strategy designed for this program is one of lecture, demonstration, and laboratory work.

The instructor will first lecture to the students covering the necessary information presented in the curriculum guide, adding any additional information that might make the information more understandable.

The instructor will then demonstrate the principles discussed in lecture. This assumes that the objective is more than information or pure theory.

The students will then be assigned laboratory experiments to conduct in order to further increase their understanding of the objective concepts, and to develop skills in equipment setup and useage.

Evaluation is divided into a number of categories.

First, lecture notes. Here the student will be evaluated on the quantity and/or quality or notes taken in class.

Second, lecture exams. Evaluation will be based on how well the student performs of instructor generated examinations.

Third, laboratory notes. The student will be evaluated on the quality and/or quantity of notes taken in the laboratory.

Fourth, laboratory exams. Evaluation will be based on how well the student preforms on instructor generated laboratory exams. The distinction between lecture exams and laboratory exams being; lecture exams cover information presented in lecture, laboratory exams cover skills and techniques developed in the laboratory.

Fifth, laboratory reports. Quality of formal reports written on laboratory experiments.

Sixth, other methods. Any other method of evaluation the instructor wished to employ.

Objective 5

Instructional Resources

Lab Equipment

Item	Manufacturer	Model #
1. Optical table	Oriel	1230
2. Optical bench	Oriel	1121
3. Mirror mount	Oriel	1770
4. Mirror mount	Oriel	1774
5. Mirror mount	Oriel	1778
6. Mirror mount	Oriel	1450
7. Three Axis Rotator	Oriel	2510
8. Translators	Oriel	1620
9. Vertical Translator	Oriel	1634
10. Rotator	Oriel	1642
11. Lens mount	Oriel	1737
12. Prism table	Oriel	1742
13. Laser	Tropel	100
14. Collimator	Tropel	280
15. Power meter	Coherent	210
16. Optical Power meter	Coherent	212
17. Spectrum Analyzer	Coherent	251
18. Driver	Coherent	216
19. Driver	Coherent	240
20. Driver	Coherent	240PP
21. Interferometer	Coherent	360-2PP
22. Focusing lens	Coherent	1557 series
23. Laser	Coherent	CR - 599
24. Laser	Coherent	CR - 699
25. Laser	Coherent	42
26. Polarizer	Coherent	19HP
27. Photodiode Amp	Coherent	32

Item		Manufacturer	Model #
28.	Electro-Optic Modulator	Coherent	3100
29.	Acousto-Optic Modulator	Coherent	308
30.	Signal Generator	Hewlett-Packard	608AB
31.	Voltmeter	H-P	410A
32.	Oscilloscope	TeKtronics	503
33.	RF Generator	H-P	608C
34.	Sweep Oscillator	H-P	3211A
35.	Quartz Halogen Lamp	Oriel	6333
36.	Quartz Halogen Housing	Oriel	6130
37.	Quartz Halogen Power Supply	Oriel	6329
38.	Photomultiplier Detector & Head	Oriel	7070 + 7060
39.	Photodiode Detector & Head	Oriel	7072 + 7052
40.	Pyroelectric Detector	Oriel	7086
41.	Neutral Density Filter	Oriel	5043
42.	Color Glass Filter	Oriel	5105
43.	Interference Filter	Oriel	5370
44.	Infrared Filter	Oriel	5404
45.	Lenses	Oriel	4008
46.	Mirrors	Oriel	4416
47.	Prisms	Oriel	4634
48.	Beamsplitter	Oriel	2611

Allen, L.
1969 Essentials of Lasers
Pergamon.

Andrews, C.
1960 Optics of the Electromagnetic Spectrum
Prentice-Hall

Anderson, J.D.
1976 Gasdynamic Lasers: An Introduction
Academic Press

Arecchi, F.T. and E.D. Schulz-Dubois
1973 Laser Handbook, Vol. 2
Elsevier

Banks, R.C.
1979 Introductory Problems in Spectroscopy
Benjamin-Cummings

Balian, R. et al
1977 Frontiers in Laser Spectroscopy
Elsevier

Barnes, F.S.
1972 Laser Theory
Wiley

Basford, L., and others.
1966 The Rays of Light - Foundations of Otpics
Ginn & Co.

Basov, N.G.
1976 Lasers and their Applications
Plenum

Bauer, G.
1962 Measurement of Optical Radiations
The Focal Press

Bausch & Lomb
1970 Diffraction Grating Handbook

Beesley, M.
1971 Lasers and their Applications
Barnes and Noble, Inc.

Biberman, M.
1966 Reticles in Electro-optical Devices
Pergamon Press

Blaker, J.
1969 Optics I - Lenses, Mirrors and Optical Instruments; Optics II - Physical and Quantum Optics
Barnes and Noble, Inc.

Bloom, A.
1968 Gas Lasers
John Wiley & Sons, Inc.

Brouwer, W.
1964 Matrix Methods in Optical Instrument Design
W.A. Benjamin, Inc.

Brown, E.B.
1974 Modern Optics
Krieger

Brown, R.
1968 Lasers: Tools of Modern Technology
Doubleday & Co., Inc.

Burroughs, W.
1977 Lasers
Crane-Russak, Co.

Cagnet, M., and others
1962 Atlas of Optical Phenomena
Springer-Verlag, Inc.

Campbell, R. and others
1972 Semiconductor Diode Lasers
Howard W. Sams Co., Inc.

Caulfield, H. and others
1970 The Applications of Holography
Wiley-Interscience

Chang, R.
1978 Basic Principles of Spectroscopy
Krieger

Charschan, S., ed.
1972 Lasers in Industry
Von Nostrand Reinhold Co.

Clarke, D.
1971 Polarized Light and Optical Measurements
Pergamon Press

Cocoran, V.J.
1978 Introduction to Lasers
Plenum

Collier, R., and others
1971 Optical Holography
Academic Press, Inc.

Conrady, A.
1957 Applied Optics and Optical Design
Dover Publications, Inc.

Cook, A.
1971 Interference of Electromagnetic Waves
Oxford University Press

Chopra, K.
1959 Thin Film Phenomena
McGraw-Hill

Cox, A.
1966 Photographic Optics
Focal Press

Cutting, T.
1949 Manual of Spectoscopy
Chemical Publishing Company

Davis, S.
1970 Diffraction Grating Spectrographs
Holt, Rinehart & Winston

DeVany, A.S.
1981 Master Optical Techniques
Wiley

Demotroeder, W.
1973 Laser Spectroscopy
Springer-Verlag

Ditchburn, R.
1953 Light
Wiley-Interscience

Drain, L.E.
1980 The Laser Doppler Technique
Wiley

Drouillard, T.F.
1979 Acoustic Emission
IFI Plenum

Duley, W.W.
1976 Carbon Dioxide Lasers: Effects and Applications
Academic Press

Edmund, N., and others
1968 Graphical Ray Tracing
Edmund Scientific Co.

Efron, A.
1969 Exploring Light
Hayden Book Company, Inc.

Elion, H.
1967 Laser Systems and Applications
Pergamon Press

Fowels, G.
1968 Introduction to Modern Optics
Holt, Rinehart & Winston

Fox, R.W.
1976 Optoelectronics Guidebook
TAB Books

Fishlock, D., ed.
1967 A Guide to the Laser
American Elesevier

Francon, M.
1966 Optical Interferometry
Academic Press

Francon, M.
1979 Optical Image Formation and Processing
Academic Press

Fry, G.
1969 Geometrical Optics
Chilton Book Co.

Gagliardi, R.M. and S. Karp
1976 Optical Communications
Wiley

Goldman, L.
1973 Applications of the Laser
CRC Press

Goldman, L., and others
197J Lasers in Medicine
Gordon & Breach

Goodman, J.
1968 Introduction to Fourier Optics
McGraw-Hill

Gunther, H.
1980 NMR Spectroscopy: An Introduction
Wiley

Habell, K., and others
1948 Engineering Optics - The Principles of Optical Methods in Engineering Measurement
Sir Isaac Pitman and Son, Ltd. (Out of print)

Harrison, G., and others
1948 Practical Spectroscopy
Prentice-Hall

Harry, J.E.
1974 Industrial Lasers and Their Applications
McGraw-Hill

Heard, H.G.
1968 Laser Parameter Measurements Handbook
Krieger

Hecht, E.
1975 Optics
McGraw-Hill

Hecht, E. and A. Zajac
1974 Optics
Addison-Wesley

Hewish, A., ed.
1970 Seeing Beyond the Visible
American Elseview

House, W.C.
1978 Laser Beam Information Systems
Petrocelli

Howarth, O.W.
1973 Theory of Spectroscopy: Elementary Introduction
Halsted Press

Ingalls, A., ed.
1973 Amateur Telescope Making, 3 Vols.
Scientific American

Jacobs, D.
1943 Fundamentals of Optical Engineering
McGraw-Hill Book Co.

Jaffe, B.
1979 Michelson and the Speed of Light
Greenwood

Jamieson, J., and others
1963 Infrared Physics and Engineering
McGraw-Hill

Jenkins, F.A.
1976 Fundamentals of Optics
McGraw-Hill

Jensen, N.
1968 Optical and Photographic Reconnaissance Systems
John Wiley

Johnson, B.
1960 Optics and Optical Instruments
Dover Publications, Inc.

Johnson, J.
1980 Lasers
Raintree Child

Jurek, B.
1976 Optical Surfaces
Elsevier

Kazovsky, L.G.
1978 Transmission of Information in the Optical Waveband
Halsted Press

Kettlekamp, L.
1979 Lasters, the Miracle Light
Morrow

Kingslake, R., ed.
1966 Applied Optics and Optical Engineering 8 Vols.
Academic Press

Klein, M.
1970 Optics
John Wiley & Sons

1971 Kodak Irtran Infrared Optical Materials
Kodak Publication # U-72, Eastman Kodak

Kressel, H.
1980 Semiconductor Devices for Optical Communications
Springer-Verlag

Kressel, H. and J.K. Butler
1977 Semiconductor Lasers and LED's
Academic Press

Kruse, P. and others
1962 Elements of Infrared Technology
John Wiley

U.S. Department of Commerce
1973 Laser Fusion Program
Lawrence Radiation Laboratory

1969 Lasers and Light
Readings from Scientific American: W.H. Freeman & Co.

1969 Laser Technology: Welding, Machining, and Safety
Penn State University, College of Engineering

Lengyel, B.
1971 Lasers, 2nd ed.
Wiley-Interscience

Levi, L.
1968 Applied Optics, Vol. 1
1980 Applied Optics, Vol. 2
Wiley

Levine, A., and others
1971 Lasers - A Series of Advances, Vol 1 through 4
Marcel Dekker, Inc.

Lewis, B.
1979 What is a Laser?
Dodd

Longhurst, R.
1957 Geometrical and Physical Optics
Longmans, Green and Co.

Lothian, G.F.
1975 Optics and it's Uses
Van Nos Reinhold

Mach, E.
1953 The Principles of Physical Optics
Dover Publications, Inc.

Macleod, H.
1969 Thin-Film Optical Filters
American Elsevier Publishing Co., Inc.

Mallow, A. and L. Chabot
1978 Laser Safety Handbook
Van Nos Reinhold

Marion, J.
1965 Classical Electromagnetic Radiation
Academic Press

Martin, L.
1960 Technical Optics
Pitman

Marton, L., and others, ed.
1968 Electron Beam and Laser Beam Technology
Academic Press

Mathieu, J.P.
1974 Optics, 2 pts.
Pergamon

Mauro, J., ed.
1966 Optical Engineering Handbook
General Electric Company

Meehan, E.J.
1964 Optical Methods of Analysis
Krieger

Metzbower, E.A.
1979 Applications of Lasers in Material Processing
ASM

Midwinter, J.E.
1979 Optical Fibers for Transmission
Wiley

Mims, F.
1975 Light-Beam Communications
Sams

Monk, G.
Light: Principles and Experiments
Dover Publications

Michaelson, A.
1902 Light Waves and Their Uses
University of Chicago Press

1927 Studies in Optics
University of Chicago Press

Muncheryan, H.
1979 Laser Technology
Sams

Nussbaum, A.
1968 Geometric Optics: An Introduction
Addison-Wesley

Olsen, E.D.
1975 Modern Optical Methods of Analysis
McGraw-Hill

Optical Glass
MIL-G-174, U.S. Gov't Printing Office

Opticalman 3 & 2
1970 U.S. GOv't. Printing Office

1941 Optics and Service Instruments
Chemical Publishing Company, Inc.

O'Shea, D.C., et al
1977 Introduction to Lasers and Their Applications
Addison-Wesley

Palmer, C.
1962 Optics Experiments and Demonstrations
The Johns Hopkins Press

Peckham, L., and others
1969 Laser Experiments for Undergraduate Electrical Engineering Students
NSF Grant GY-4761, Tech. Report #1

Pike, C.
1967 Lasers and Masers
Howard W. Samms & Co., Inc.

Polyani, T., and others
1970 Principles and Properties of the Laser
American Optical Corporation

Poole, H.
1966 Fundamentals of Display Systems
Spartan Books

Pratt, W.
1969 Laser Communications Systems
John Wiley & Sons, Inc.

1970 RCA Photomultiplier Manual
RCA Electronic Components

Ready, J.
1971 Effects of High-Power Laser Radiation
Academic Press

Robinson, J.W.
1980 Handbook of Spectroscopy
CRC Press

Ross, D.A.
1979 Optoelectronic Devices and Optical Imaging Techniques
Scholium

Rossi, B.
1957 Optics
Addison-Wesley

Sargent, M. et al
1974 Laser Physics
Addison-Wesley

Sawyer, R.,
1963 Experimental Spectroscopy, 3rd ed
Dover Publications

Schafer, F.P.
1977 Dye Lasers
Springer-Verlag

Shulman, A.
1970 Optical Data Processing
John Wiley & Sons, Inc.

Shurcliff, Wl
1962 Polarized Light: Production and Use
Harvard University Press

Siegman, A.
1971 An Introduction to Lasers and Masers
McGraw-Hill

Sinclair, D., and others
1969 Gas Laser Technology
Holt, Rinehart and Winston, Inc.

Slayter, E.
1970 Optical Methods in Biology
Wiley-Interscience

Smith, W.
1966 Modern Optical Engineering
McGraw-Hill

Smith, W.V.
1970 Laser Applications
Artech House, Inc.

Smith, W.V. and others
1966 The Laser
McGraw-Hill

Society of Photo-Optical Instrumentation Engineers
1975 Impact of Lasers in Spectroscopy
Photo-Optical

S.P.I.E.
1965 Basic Optics and Optical Instruments, Vol. 1
Nortronics Division of the Northrop Corporation

Steele, W.
1967 Interferometry
Cambridge University Press

Steele, E.
1968 Optical Lasers in Electronics
Krieger

Steinfeld, J.I.
1976 Electronic Transitions Lasers
MIT Press

Steinfeld, J.I.
1978 Laser and Coherence Spectroscopy
Plenum

Stitch, M.L.
1979 Laser Handbook
Elsevier

Stroke, G.
1966 An Introduction to Coherent Optics and Holography
Academic Press

Stone, J.
1963 Radiation and Optics
McGraw-Hill

Strong, J.
1939 Procedures in Experimental Physics
Prentice-Hall, Inc.

1958 Concepts of Classical Optics
W.H. Freeman, & Co.

Svelto, O.
1976 Principles of Lasers
Plenum

Texereau, J.
1963 How to Make a Telescope
Doubleday & Co., Inc.

Tippett, J., and others, ed.
1964 Optical and Electro-Optical Information Processing
Massachusetts Institute of Technology Press

Tolansky, S.
1955 An Introduction to Interferometry
Longmans, Green and Co.

1965 Curiosities of Light Rays and Light W Waves
American Elsevier

Twyman, F.
1952 Prism and Lens Making
Hilger and Watts, Ltd. (Out of print)

1955 Optical Glassworking
Hilger & Watts, Lts. (Out of print)

U.S. Navy
1969 Basic Optics and Optical Instruments
Dover

Unger, H.G.
1970 Introduction to Quantum Electronics
Pergamon

Van Pelt, W., and others
Laser Fundamentals and Experiments
Southwestern Radiological Health Laboratory

Wacker, C.H.
1973 Lasers: How They Work
Putnam

Weber, J.
1968 Lasers, 2 Vols.
Gordon

Willet, C.S.
1974 Gas Lasers
Pergamon

Williams, C., and others
1972 Optics: A Short Course for Engineers and Scientists
Wiley-Interscience

Wolbarsht, M.L.
1971 Laser Applications in Medicine and Biology
Plenum

Wolf, E.
1976 Progress in Optics, 14 Vols.
Elsevier

Wolfe, W., ed.
1965 Handbook of Military Infrared Technology
Office of Naval Research

Wood, R.
1961 Physical Optics, 3rd ed.
Dover

Yariv, A.
1971 Introduction to Optical Electronics
Holt, Rinehart and Wisnton, Inc.

Yu, F.T.
1976 Optics and Information Theory
Wiley

Deboo, G. and others.
1971 Integrated Circuits and Semiconductor Devices: Theory and Application
McGraw-Hill

Diefenderfer, A.
1972 Principles of Electronic Instrumentation
W.B. Saunders

Fiske, K. and others
Solid State Circuit Analysis
The Technical Education Press

Gaddis, B.
1972 Troubleshooting Solid-State Electronic Power Supplies
Tab Books

Grob,
1979 Basic Electronics
McGraw-Hill

Grabinski, J.
1969 Electronic Power Supplies
Holt, Rinehart and Winston, Inc.

Grove, A.
1967 Physics and Technology of Semiconductor Devices
Wiley

Kaufman, Milton and Arthur H. Seidman
1976 Handbook for Electronics Engineering Technicians
McGraw-Hill

Malmstadt, H., and others
1963 Electronics for Scientists
W.A. Benjamin, Inc.

Malvino, Albert
1979 Electronic Principles
McGraw-Hill

Markus, J.
1968 Sourcebook of Electronic Circuits
McGraw-Hill

Millman, J., and others
1967 Electronic Devices and Circuits
McGraw-Hill

Mulvey, J., and others
1968 Semiconductor Device Measurements
Tektronix, Inc.

Kloeffler, Royce G., Maurice W. Horrell, Lee E. Hargrave, Jr.
1969 Basic Electronics
John Wiley & Sons

 (continued)

Shrader, Robert
1980 Electronic Communications
McGraw-Hill

Abbott, A.F.
1977 Ordinary Level Physics
Heinemann

Adair, R.
1969 Concepts in Physics
Academic Press

Alonso, M. and E.J. Finn
1979 Fundamental University Physics
Addison-Wesley

Arya, A.P.
1974 Elementary Modern Physics
Addison-Wesley

1979 Introductory College Physics
MacMillian

Beiser, A.
1972 Basic Concepts of Physics
Addison-Wesley

Bennett, C.E.
1970 Physics Without Mathematics
Harper-Row

Blackwood, O.H.
1973 General Physics

Goswami, A.
1979 The Concept of Physics
Heath

Miller, F.
1977 College Physics
Harcourt-Brace-Jovanovich

White, M.W. et al
1968 Basic Physics
McGraw-Hill

Williams, G.A.
1976 Elementary Physics
McGraw-Hill

Woolfson, M.M
1978 Trends in Physics
Heyden

Algebra

Bramson, M.
1978 Algebra: An Incremental Approach
Prentice-Hall

Easton, R.J. and G.P. Graham
1973 Intermediate Algebra
Wiley

Keedy, M.L. and M.L. Bittinger
1976 Algebra, A Modern Introduction, 12 vols.
Addison-Wesley

Sigler, L.E.
1977 Algebra
Springer-Verlag

Wooton, W. and I. Drooyan
1979 Intermediate Algebra
Wadsworth

Trigonometry

Barker, C.C.
1968 Introduction to Trigonometry
Philos Lib

Cavanagh, T.D.
1969 Modern Trigonometry
Wadsworth

Denney, F.C.
1976 Trigonometry
Harper-Row

Nanney, J.L. and J.L. Cable
1979 Trigonometry: A Skills Approach

Heineman, E.R.
1974 Plan Trigonometry with Tables
McGraw-Hill

Stockton, D.S.
1979 Essential Trigonometry
Houghton-Mifflin

Addendum, Resource List

All titles published by Academic Press

LASER APPLICATIONS, Vol. 1, 1971
Vol. 2, 1974
Vol. 3, 1977
Vol. 4, 1980

Anderson: GASDYNAMIC LASERS, 1976
Arnaud: BEAM AND FIBER OPTICS, 1976
Barnowski: FUNDAMENTALS OF OPTICAL FIBER COMMUNICATIONS, 1976
Bell: INTRODUCTORY FOURIER TRANSFORM SPECTROSCOPY, 1972
Bube: ELECTRONS IN SOLIDS, 1980
Button: INFRARED AND MILLIMETER WAVES,
Vol. 1: Sources of Radiation, 1979
Vol. 2: Submillimeter Techniques, 1979
Vol. 3: Submillimeter Techniques, 1980
Casey/Panish: HETEROSTRUCTURE LASERS, 1978
Part A: Fundamental Principles
Part B: Materials and Operating Characteristics
Caulfield: HANDBOOK OF OPTICAL HOLOGRAPHY, 1979
Chantry: MODERN ASPECTS OF MICROWAVE SPECTROSCOPY, 1979

Chu: LASER LIGHT SCATTERING, 1974
Close: AN INTRODUCTION TO QUARKS AND PARTONS, 1980 paper

Cornbleet: MICROWAVE OPTICS, 1976
Crosignani et al: STATISTICAL PROPERTIES OF SCATTERED LIGHT, 1975

Dahl: INTRODUCTION TO ELECTRON AND ION OPTICS, 1973
Dainty/Shaw: IMAGE SCIENCE, 1974
Deepak: REMOTE SENSING OF ATMOSPHERES AND OCEANS, 1980
Deepak et al: ATMOSPHERIC WATER VAPOR, 1980
Duley: LASERS, EFFECTS AND APPLICATIONS, 1976
Erf: SPECKLE METROLOGY, 1978
Ferraro/Basile: FOURIER TRANSFORM INFRARED SPECTROSCOPY,
Vol. 1, 1978
Vol. 2, 1979

Francon: HOLOGRAPHY, 1974
Francon: LASER SPECKLE AND APPLICATIONS IN OPTICS, 1979
Francon: OPTICAL IMAGE FORMATION AND PROCESSING, 1979
Frungel: HIGH SPEED PULSE TECHNOLOGY,
Vol. 1: Capacitor Discharges, Magneto-hydrodynamics, X-Rays, Ultrasonics, 1965
Vol. 2: Optical Pulses, Lasers, Measuring Techniques, 1965
Vol. 3: Capacitor Discharge Engineering, 1975
Vol. 4: Sparks and Laser Pulses, 1980
Fromhold: QUANTUM MECHANICS FOR APPLIED PHYSICS AND ENGINEERING, 1981
Gradshteyn et al: TABLES OF INTEGRALS, SERIES AND PRODUCTS, 1980
Grum/Becherer: OPTICAL RADIATION MEASUREMENTS,
Vol. 1: Radiometry, 1979
Grum/Bartleson: OPTICAL RADIATION MEASUREMENTS,
Vol. 2: Color Measurement, 1980

Helstrom: QUANTUM DETECTION AND ESTIMATION THEORY, 1976
Harper/Wherrett: NONLINEAR OPTICS, 1977
Herman: TREATISE ON MATERIALS SCIENCE AND TECHNOLOGY,
Vol. 18: Ion Implantation, 1980
Hlawiczka: INTRODUCTION TO QUANTUM ELECTRONICS, 1972
Hufner: OPTICAL SPECTRA OF TRANSPARENT RARE EARTH COMPOUNDS, 1978
Ishimaru: WAVE PROPAGATION AND SCATTERING IN RANDOM MEDIA,
Vol. 1: Single Scattering and Transport Theory, 1978
Vol. 2: Multiple Scattering, Turbulence, Rough Surfaces, and Remote Sensing, 1978
Kaminow: AN INTRODUCTION TO ELECTROOPTIC DEVICES, 1974
Kapany: FIBER OPTICS, 1967
Kapany/Burke: OPTICAL WAVEGUIDES, 1972
Kartaschoff: FREQUENCY AND TIME, 1978
Keeney: SITING ENERGY FACILITIES, 1980

Kingslake: LENS DESIGN FUNDAMENTALS, 1978
Kressel/Butler: SEMICONDUCTOR LASERS AND HETEROJUNCTION LEDS, 1977
Marchand: GRADIENT INDEX OPTICS, 1978
Marcuse: THEORY OF DIELECTRIC OPTICAL WAVEGUIDES, 1974
Marcuse: PRINCIPLES OF QUANTUM ELECTRONICS, 1980
Miller/Chynoweth: OPTICAL FIBER TELECOMMUNICATIONS, 1979
Motz: THE PHYSICS OF LASER FUSION, 1979
Murr: SOLAR MATERIALS SCIENCE, 1980
Nader: NO ACCESS TO LAW, 1980
Nagel et al: ILLUMINATION, COLOR AND CONTRAST TABLES:
Naturally Illuminated Objects, 1978
Pao: OPTOACOUSTIC SPECTROSCOPY AND DETECTION, 1977
Rabin/Tang: QUANTUM ELECTRONICS,
Vol. 1, Part A, 1975
Vol. 1, Part B, 1975
Ready: EFFECTS OF HIGH-POWER LASER RADIATION, 1971
Ready: INDUSTRIAL APPLICATIONS OF LASERS, 1978
Rickayzen: GREEN'S FUNCTIONS AND CONDENSED MATTER, 1981
Tang: QUANTUM ELECTRONICS, Part A, 1979
Vanasse: SPECTROMETRIC TECHNIQUES,
Vol. 1, 1977
Vol. 2, 1981
Van de Hulst: MULTIPLE LIGHT SCATTERING,
Vol. 1, 1980
Vol. 2, 1980
Welford/Winston: THE OPTICS OF NONIMAGING CONCENTRATORS;
Light and Solar Energy, 1978
Whalen: DETECTION OF SIGNALS IN NOISE, 1971
White/Peercy: LASER AND ELECTRON BEAM PROCESSING OF MATERIALS, 1980
Wyatt: RADIOMETRIC CALIBRATION, 1978

IN PRESS TITLES — PUBLICATION DATE

Button: INFRARED AND MILLIMETER WAVES, Vol. 4 — August, 1981

HUTCHINSON ROSS PUBLISHING COMPANY TITLES

Harger: OPTICAL COMMUNICATION THEORY, 1977
Hudson/Hudson: INFRARED DETECTORS, 1975
Swindell: POLARIZED LIGHT, 1975
Tyler: LIGHT IN THE SEA, 1977

JOURNALS

The following journals have published numerous articles on lasers, laser systems, and associated laser data:

Applied Optics
American Institute of Physics
335 E. 45th Street
New York, NY 10017

Lasers: A Series of Advances
Marcel Dekker
95 Madison Ave.
New York, NY 10016

American Journal of Physics
American Association of Physics Teachers
Physics Building
SUNY at Stony Brook
Stony Brook, NY 11794

Aviation Week and Space Technology
McGraw-Hill, Inc.
P.O. Box 430
Hightstown, NJ 08520

Journal of Applied Physics
American Institute of Physics
335 E. 45th Street
New York, NY 10017

Science
American Association for the Advancement of Science
1515 Massachusetts Ave. NW
Washington DC 20005

Optical Society of America, Journal
American Institute of Physics
335 E. 45th Street
New York, NY 10017

Laser Focus
International Data Publishing Co.
P.O. Box 1
Newtonville, Mass.

Electro-Optical Systems Design
Kiver Publications
222 W. Adams
Chicago, IL 60606

Laser Abstracts
Plenum Press
227 W. 17th Street
New York, NY 10011

Laser Journal
A.Z. Publishing Corp.
647 N. Sepulveda Blvd.
Los Angeles, CA 90049

Laser Newsweek
Lowry-Cocroft
516 Main Street
Evanston, IL

AUDIO VISUAL

Video Tapes

Laser - Miracles with Light
U.S. National Audiovisual Center
General Services Administration
Washington D.C. 20409

Laser, The - A Light Fantastic
Union Carbide Corp.
270 Park Ave.
New York, NY 10017

Optical Phenomena
Chicago's TV College
WTTW - TV
5400 N. St. Louis
Chicago, IL 60625

Optics - A Series
Center for Educational TV
Overseas
London, England

Film Strips

Lasers
Activity Records
1597 Grand Ave.
Baldwin, NY 11510

Optics - Diffraction and Interference
Optics - Modern Concepts of Light
Optics - Reflection of Light, Curved Mirrors
Optics - Reflection of Light, Plane Mirrors, and Optical Fibers
Optics - Refraction of Light, Lenses
Prentice-Hall Media
150 White Plains Rd.
Tarrytown, NY 10591

Optics and Lenses
Eye Gate House, Inc.
146-01 Archer Ave.
Jamaica, NY 11435

Optical Principles
Holt, Rinehart and Winston
383 Madison Ave.
New York, NY 10017

Audio Tapes

Laser Fusion
Pacifica Tape Library
5316 Venice Blvd.
Los Angeles, CA 90019

Lasers/Nuclear Power Generation
Science Workshop, Inc.
P.O. Box 9785
Atlanta, GA 30319

Slides

Laser Principles and Applications
Amer Educational Services
P.O. Box 308
North Wilbraham, MA 01067

Laser Safety
Laser Laboratory
Eden & Bethesda Aves.
Cincinnatti, OH 45219

Optical Devices
Peter Nicastro
196 Harrison Drive
Garfield, NJ 07026

Films - 16mm

Holography
National Science Foundation
1800 G Street, NW
Washington D.C. 20550

Holography
KCET
4400 Sunset Drive
Los Angeles, CA 90027

Holography, Window to the Future
U.S. Veterans Administration
Vermont at H Street
Washington D.C. 20420

Laser - Miracles with Light
U.S. Army
The Pentagon
Washington D.C. 20310

Laser - The Light of the Future
Prism Productions
531 Dawson Drive
Camarillo, CA 93010

Laser Beam, The
Handel Film Corp.
8730 Sunset Blvd.
W. Hollywood, CA 90069

Laser Light
Scientific American
415 Madison Ave.
New York, NY 10017

Laser Safety
NASA
Code FAD
Washington D.C. 20546

Laser Safety
Univ. of Calif. Ext. Media Center
2223 Fulton Street
Berkely, CA 94720

Optical Inspection Methods, Pts. 1 & 2
U.S. Navy Dept.
Office of Information
Pentagon Bldg.
Washington D.C. 20350

Films - 8mm Cartridges

Holography
Thorne Films, Inc
1229 University Ave.
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Laser - A Light Fantastic
CBS - TV
51 W. 52nd Street
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Southbridge, MA 01550

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Dedham, MA 02026

ASM (American Society for Metals)
9275 Kingsman Road
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81 Adams Drive
Totowa, NY 07512

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32 E. 57th Street
New York, NY 10022

Chemical Publishing
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Chilton Way
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New York, NY 10016

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Garden City, NY 11530

Dover Publications
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2 Park Street
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IFI Plenum
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The Johns Hopkins Press
Baltimore, MD 21218

Krieger
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Cambridge, MA 02142

Morrow, William
105 Madison Avenue
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NSF (National Science Foundation)
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Northrop Corp.
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